PROSPECTIVE AND RETROSPECTIVE ANALYSIS OF ORTHOPAEDIC & DOMICILIARY REHABILITATION OUTCOME OF SPINE INJURY PATIENTS TREATED WITH CONSERVATIVE AND OPERATIVE METHODS

Dissertation submitted to

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With fulfillment of the regulations
for the award of the degree of

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BRANCH – II

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CERTIFICATE

This is to certify that this dissertation titled **"PROSPECTIVE AND RETROSPECTIVE ANALYSIS OF ORTHOPAEDIC & DOMICILIARY REHABILITATION OUTCOME OF SPINE INJURY PATIENTS TREATED WITH CONSERVATIVE AND OPERATIVE METHODS"** is a bonafide record of work done by **DR.PRAMOD KUMAR MOHAN,** during the period of his postgraduate study from April 2016 to September 2016 under guidance and supervision in the Institute of Orthopaedics and Traumatology, Madras Medical College and Rajiv Gandhi Government General Hospital, Chennai-600003, in partial fulfillment of the requirement for **M.S.ORTHOPAEDIC SURGERY** degree Examination of the Tamilnadu Dr M.G.R. Medical University to be held in April 2017.

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DECLARATION

I declare that the dissertation entitled **"PROSPECTIVE AND RETROSPECTIVE ANALYSIS OF ORTHOPAEDIC & DOMICILIARY REHABILITATION OUTCOME OF SPINE INJURY PATIENTS TREATED WITH CONSERVATIVE AND OPERATIVE METHODS"** submitted by me for the degree of M.S is the record work carried out by me during the period of **April 2016 to September 2016** under the guidance of **PROF.N.DEEN MUHAMMAD ISMAIL, M.S.ORTHO., D. Ortho.,** Professor of Orthopaedics, Institute of Orthopaedics and Traumatology, Madras Medical College, Chennai. This dissertation is submitted to the Tamilnadu Dr.MGR. Medical University, Chennai, in partial fulfilment of the University regulations for the award of degree of M.S.ORTHOPAEDICS (BRANCH-II) examination to be held in April 2017.

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CONTENTS

INTRODUCTION

Traumatic Spinal cord injury (SCI) the most devastating orthopaedic injury resulting in serious disability among patients, his family and society. Following SCI, severity of disability is estimated at 72%.As defined by Chin and colleagues, spinal cord injury (SCI) is "an insult to the spinal cord resulting in a change, either temporary or permanent, in its normal motor, sensory, or autonomic function." [1].

The life expectancy and outcome of persons with SCI were poor for centuries in the past. Now at present, concept is shifted to comprehensive rehabilitation of the spinal cord injured patient and the ultimate goal is to reintegrate them into the society as functionally useful, productive person. Good and efficient rehabilitation is the key to reintegrate the individual to society.

The concept of rehabilitation in SCI was pioneered by Donald Munro (1889-1973) in the USA, Ludwig Guttman (1899-1980) in United Kingdom and Sir Geoffrey Bedbrook in Australia. In India, first organised rehabilitation was started by Dr Mary Varghese in CMC, Vellore and also pioneered by Dr A S Chahal , Major HPS Ahluwalia.[2]

Outcome measurement scales like FIM, ASIA Motor score, modified Barthel Index were designed to evaluate the efficacy of the rehabilitation to the SCI patients. Presently in Indian subcontinent studies are limited particularly in spinal cord injury rehabilitation.

Summarising there has been a dramatic change in approach of management of SCI patients, from an ailment considered not to be treated to present situation where it is an ailment to be treated and in near future ,an ailment to be cured.

The aim of this study is to analyse the efficacy of the comprehensive rehabilitation on the final outcome of the SCI patient and also to study the role of demography statistics, mode of injury, commonly adopted acute care management, social and environment barrier in final outcome

AIM OF THE STUDY

To analyse the functional outcome of rehabilitation in spinal cord injury patients in hospital and community setup and study was conducted in our Institute of Orthopaedics and Traumatology and Government Institute of Rehabilitation medicine, KK Nagar, Madras Medical College and Rajiv Gandhi Government General Hospital between the period of April 2016 and September 2016.

- **Design of study:**

  Prospective cum retrospective study, 40 patients are involved in this study.

- **Proposed period of study**:

  April 2016- September 2016

REVIEW OF HISTORY

Edwin smith Papyrus, Egyptian Physician 3000-2500BC -Described first known record of SCI, described it as an 'ailment not be treated'. [3]

Hippocrates, Aulus Cornelius Celsus , Galen -Advocated methods of traction techniques in order to reduce SCI.[3]

Paul of Aegina, 625–690 AD, Greece -First to perform surgery for SCI. [4]

Roland of Parma, 1210, Italy -Was the first to emphasise the importance of early intervention for SCI. [4]

Ambroise Paré, 1564, France -Wrote the Ten Books of Surgery, recommending laminectomy for spinal cord compression, and methods of reducing dislocation, namely manual reduction and splinting. [4]

Gerard Blasius, 1666, Netherlands -Published Anatome medullae spinalis, et nervorum inde proventium, the first work written solely about the spinal cord. [5]

Sir Astley Cooper, 1823, United Kingdom -Described the effects of SCI at different levels and corresponding prognoses, he recorded SCI patients living as long as 2 years and being rehabilitated. [6]

Alban Gilpin Smith, 1829, United States -Performed the first successful lumbar laminectomy.[7]

Marshall Hall, 1841, United Kingdom -Coined the term 'spinal shock' [3].

Sir William Gull, 1881, United Kingdom -Introduced the term quadriplegia for what was previously called cervical paraplegia. [8]

Alfred Reginald Allen, 1911 United States -Postulated the concept of secondary injury in SCI and promoted the concept of early decompression following SCI [9]

George Riddoch ,1915–1916 ,United Kingdom -Developed a system of medical care for SCI patients in a new Royal Army unit that dramatically improved the survival rate (from less than 10% to almost 90%)[10].

Von Lackum and DeForest-Smith, 1924, United States -Performed the first anterior spinal surgery. [11]

Donald Munro, 1936, United States (Boston) -Started the first spinal cord unit, providing holistic care to prevent complications and facilitate rehabilitation to allow societal reintegration. [12]

Ernest Bors, 1950, United States -After developing a paraplegia management program at a military hospital during the war, established a SCI centre at a veteran's hospital in California. [3]

Botterel of Toronto, -Showed ambulation possible with crutches. The concept of comprehensive rehabilitation both medical and non-medical aspects like social, environmental factors play a major role in SCI rehabilitation. This has produced promising results for **Guttmann** in UK, **Nakamura** in Japan. [2]

1954 United States – American Paraplegia Society established (now publishes the Journal of Spinal Cord Medicine).[4]

George Bedbrook, 1954, Australia -Established the first Australian spinal injury unit, in Perth. [2]

Paul Harrington, 1958, United States - Developed Harrington instrumentation system of rods and hooks. [2]

1961 United Kingdom – International Medical Society of Paraplegia established (now International Spinal Cord Society, and publishes the journal Spinal Cord). [13]

Paul Harrington, 1966, United States -Designed a pedicle screw (for use in spondylolisthesis), which provided three-column support and greater stability. [2]

Thomas Ducker and Harold Hamit, 1969, United States -Based on animal studies, proposed steroid administration for SCI patients within 3 hours of injury. [14]

Emanuele Manerino, 1980s, United States -Established a fellowship program for training in SCI care. [6]

Flanders et al., 1990, United States -Findings on MRI found to correlate with degree of neurological deficit in SCI patients.[15]

Keirstead et al., 2005, United States -Demonstrated that transplanted human embryonic stem cell-derived oligodendrocyte progenitor cells enhanced remyelination and improved neurological function in the context of spinal cord injury in a rat model. [16]

Mackay-Sim et al. 2008, Australia -Phase I/IIa trial of transplantation of autologous olfactory ensheathing cells into spinal cord injured patients concluded that the procedure is safe. [17]

2009 United States – United States Food and Drug Administration approved trial of human embryonic stem cells therapy for spinal cord injury [3]

REVIEW OF LITERATURE

In study by **Burns et al** in 1997 , involving 105 ASIA C/D patients concluded that 91% of ASIA C patients younger than 50 years became ambulatory by discharge, versus 42% of those older than 50 years ,All ASIA D patients became ambulatory by discharge and study was based on outcome of ambulation after rehabilitation.[18]

Cifu et al in 1999 studied 375 cervical injuries and based on FIM scores concluded younger patients' scores on the FIM motor subscale improved significantly more than did the older groups .[19]

In study by **Furlan et al** in 2009 involving 499 injuries and based on FIM scores suggested that patients >65 years experienced greater functional deficit (based on FIM scores) than younger individuals despite experiencing similar rates of sensorimotor recovery. [20]

Kay et al in 2007 studied 343 patients based on FIM scores reported ambulation depends on initial ASIA scale presentation with outcome directly proportional to increasing ASIA scale. [21]

Study by **Ota et al** in 1996 with 100 complete motor injuries proposed that sequential increase in mean FIM scores at follow-up with a more caudal initial level of injury .[22]

In study by **Sipski et al**, 2004 with 14,433 injuries suggested men had higher FIM motor scores at rehab discharge as compared to women among those with motor complete lesions based on FIM scores after rehabilitation. [23]

EPIDEMIOLOGY & DISTRIBUTION

In India

Annual incidence - 15 new cases /million/ year

Male: female of 3:1 with average age incidence of 20-30 years.

International Conference (Spinal Injuries Management, New Delhi, 1995) [25]

In Canada

Annual incidence- 40 / million/year [24]

In Portugal

Annual Incidence - 57.8 /million / year (Highest) [24]

In Australia

Annual incidence - 14.5 /million/year (Lowest) [24]

Among developing countries,

Brazil has male: female ratio of 4.4:1 with average age incidence of 34 years [25]

China has male: female ratio of 5.6:1 with average age incidence of 46 years [25]

Pakistan has male: female ratio of 4.5:1 with average age incidence of 29.3 years [25]

Mode of injury

Motor vehicle accidents (30-60% of injuries)

Falls (20-60% injuries) [26]

Remaining injuries secondary to violence, sports related/diving accidents, or work related accidents

Globally , Road traffic accidents were major cause of SCI and falls contributing second major cause while Fall injury were major cause of SCI in India.[24]

Level of injury distribution

Cervical levels-55-75%

Remaining roughly equally distributed between thoracic and lumbosacral level [26]

Age distribution of SCI

Bimodal

First peak- adolescence/young adulthood ages of 15 and 30 (related to an increase in injuries secondary to violence, sports accidents, and motor vehicle accidents)

Second peak - greater than 70 years old (related to an increase in fall related SCI in the elderly. [27]

ANATOMY

Adult spine have 7 cervical, 12 thoracic, 5 lumbar, and 5 sacral vertebrae. The coccyx have up to 5 fused segments and kyphotic at thoracic and lordotic at cervical and lumber level.

The neural arch consists of pedicle, lamina, superior and inferior articular processes, transverse processes and a spinous process. The pedicles connect the vertebral bodies to the posterior elements—laminae and spinous processes.

The facet joint is a diarthrodial joint, in the cervical region the superior articular facets face cranially and posteriorly, providing some stability in forward motion while allowing mobility

The thoracic facets are oriented in the coronal plane, preventing forward motion, whereas the lumbar facets are oriented mostly in the sagittal plane, preventing axial rotation and lateral movement of one vertebra in relation to adjacent vertebrae while allowing flexion and extension.

Vertebral discs consist of two major parts: the nucleus pulposus and the annulus fibrosus and acts as shock absorber. Adult discs have no blood supply and their nutrition is provided by diffusion from end plate blood vessels

The anterior longitudinal ligament (ALL) extends from C1 to the sacrum and attaches to the anterior aspect of the vertebral bodies, mostly at the cranial and caudal portions of the vertebral bodies, and to the anterior aspect of the inter vertebral discs. The PLL extends from the axis to the sacrum, is located within the spinal canal, and is attached to the posterior wall of the vertebral bodies as well as to the discs.

. The spinal canal contains the spinal cord and the nerve roots. The spinal cord, which is the continuation of the brain stem, extends from the foramen magnum to the L1-L2 level. The lower tip of the spinal cord—the conus medullaris—is a cone-shaped structure pointing downward that contains the centres for micturition and defecation .Below the L1-L2 level the spinal canal contains the lumbar and sacral nerve roots, which exit through their respective foraminae. As they course down toward their exit points they form the cauda equina.

VERTEBRAL LEVELS OF SPINAL CORD SEGMENTS

	Bony vertebral Level	**Spinal Segment level**
1	Cervical	One level is added.
2.	Thoracic D1 –D6	Two levels are added.
3.	Thoracic D7 – D9	Three levels are added.
4.	Thoracic D10	L1 –L2.

5. Thoracic D11 L3 –L4.

6. Thoracic D12 L5.

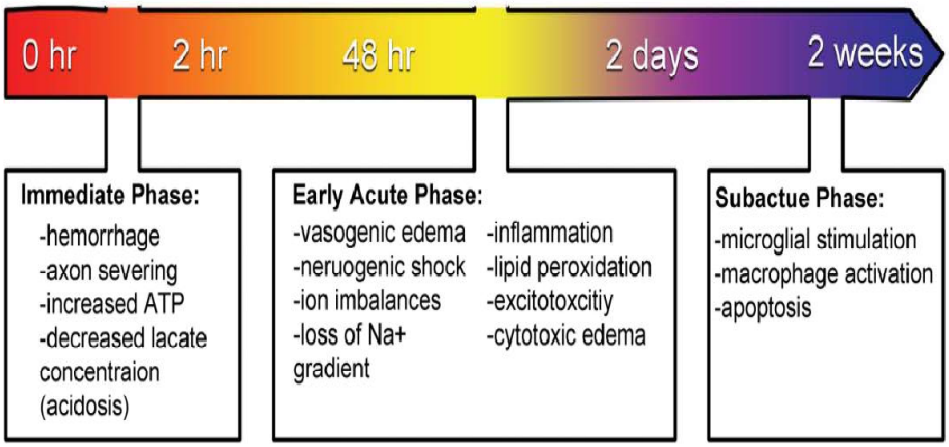
7. Lumbar L1 Sacral segments.

CHARACTERISTICS OF SPINE

Characteristic	Cervical spine	Thoracic spine	Lumbar spine
Body	Small, wide side to side	Larger than cervical; heart shaped; bears two costal facets.	Massive; kidney shaped.
Spinous process	Short & bifid	Large & sharp	Short & blunt
Vertebral foramen	Triangular	Circular	Triangle
Transverse process	Contain foramina	Bears facets for ribs	Thin & tapered
Superior &inferior articulating processes	Flexion and extension; lateral flexion; rotation	Rotation; lateral flexion possible but limited by ribs	Flexion & extension; some lateral flexion; rotation prevented

PATHOPHYSIOLOGY

Traumatic SCI causes initial mechanical disruption of tissue which leads to a complex secondary sequence of patho-physiological changes and neurological impairment. This sequence depends on the amount of impact sustained to the spinal cord at the time of injury. “Schematic illustrating the time related progression of secondary injury related pathological mechanisms after the primary injury event. These secondary events increase neural tissue damage and negatively impact long-term clinical outcomes.”



Pathophysiologcial Event

The injury patterns are primary or secondary.

The primary neurological injury:

a. Contusion: Transient compression resulting in intramedullary haemorrhage, and vascular injury.

b. Compression: The mechanical deformation interferes with axonal flow and causes ischemia

c. Laceration: There is physical separation.

Secondary Injury:

Ischaemia, vasoactive substances, swelling and pressure effects results in secondary injuries. Late sequel includes chronic pain, neurological deterioration due to scar and syringomyelia.

BIO MECHANICS OF HUMAN SPINE

Denis developed three column concept which was developed following a CT scan

study of thoracolumbar injuries.

Anterior Column:

Anterior longitudinal ligament

Anterior half of vertebral body

Anterior portion of annulus fibrosis

Middle column:

Posterior longitudinal ligament

Posterior half of vertebral body

Posterior aspect of annulus fibrosis

Posterior column:

Neural arch

Ligamentum flavum

Facet capsule

Interspinous ligament

The thoracic spine is stiffer than lumbar spine due to the rib cage and has smaller and thinner discs. The movements happening in cervical spine are flexion, extension and lateral flexion. The movements at thoracic spine are rotation and lateral flexion, while flexion and extension are more at lumbar spine

CLASSIFICATION OF CERVICAL SPINE INJURIES

Type A: Compression injuries of the body (compressive forces)

Type A1: Impaction fractures

Type A2: Split fractures

Type A3: Burst fractures

Type B: Distraction injuries of the anterior and posterior elements (tensile forces)

Type B1: Posterior disruption predominantly ligamentous (flexion-distraction injury)

Type B2: Posterior disruption predominantly osseous

(flexion-distraction injury)

Type B3: Anterior disruption through the disc (hyperextension-shear injury)

Type C: Multidirectional injuries with translation affecting the anterior and posterior elements (axial torque causing rotation injuries)

Type C1: Rotational wedge, split, and burst fractures

Type C2: Flexion subluxation with rotation

Type C3: Rotational shear injuries (Holdsworth slice rotation fracture)

CLASSIFICATION OF THORACOLUMBAR FRACTURES

McAffe Classification: [28]

1. Wedge compression fracture
2. Stable burst fracture
3. Unstable burst fracture
4. Chance fracture
5. Flexion distraction injuries
6. Translational injuries

DENIS CLASSIFICATION:

1) Burst fractures
2) Wedge compression fracture
3) Fracture Dislocation
4) Flexion Distraction Injuries

PATTERNS OF INJURY

Following trauma, according to Sherrington a stage of spinal shock develops which lasts for hours to days with complete loss of sensation, motor and reflex activity. Once spinal shock is over, reflex activity returns, with onset of spontaneous reflex activity below the level of lesion leading to spasticity.

Complete Lesion

A complete lesion is present when there is no motor, sensory or voluntary bladder and bowel function distal to injury with a preserved bulbocavernous reflex.[31]

Incomplete Lesion

It exists when some function persists below the level of lesion, like sacral sparing, voluntary bladder or rectal function or great toe flexion activity. Prognosis for recovery in incomplete lesion is good.

Spinal cord injury Syndromes

1. Anterior cord syndrome

It results in hyperreflexia, atropy, and variable motor loss with the preservation of position sensation but impaired pin prick and temperature sensation. It occurs secondary to flexion rotation force resulting in dislocation. Recovery is poor.

2. Central cord syndrome

The features include weakness greater in arms than legs, lower extremity hyperreflexia, upper extermity mixed UMN & LMN weakness and preserved sacral sensation with potential for preservation of bowel and bladder control. It occurs secondary to hyperextension injury on a cervical spondylotic spine. Recovery is good.

3. Brown – Sequard Syndrome

This presents with hemi-or-monoplegia or paresis with contralateral pain and temperature deficit. There is a good prognosis for motor recovery progressing from the proximal extensors to distal flexors. This results from penetrating injuries and secondary to hemisection of the spinal cord.

4. Posterior cord syndrome

Manifest as bilateral deficits in proprioception resulting from hyper extension injury. Ataxia due to proprioception loss is the main feature.

NEURONAL RECOVERY AFTER SCI

Neural recovery occurs rapidly during first and second week. Then recovery continues at a slower pace for the first 4 months and the ability of the chronically injured axon to initiate a regeneration response is unexpected.

Central Mechanisms

Cortical reorganization such as recruitment of latent pathways, which are unused until injury, is one of major mechanism of recovery. At the site of injury, edema and haematomyelia may resolve reducing secondary injury. Recovery from neuropraxia and demyelination associated with Central Synaptogenesis which may occur in response to denervation Hypersensitivity of the anterior horn cell are the other mechanisms of recovery.Root impingement may resolve with decompression and spinal alingnment.

In a study the intensity of the lesion (incomplete) and vertebral displacement were statically associated with neuronal recovery. Age less than 30 years at the moment of injury in incomplete lesion is also associated with good neuronal recovery. Degree of vertebral wedging, type of fracture, management (conservative or surgical) and neurological evolution do not have any association with neurological recovery.

DIAGNOSIS

Any patient suspected of spinal trauma should be evaluated in emergency trauma ward for Airway, Breathing and Circulation. Initial resuscitation is done with nasal oxygen and intravenous fluids. Cervical spine immobilization is done with hard cervical collar. Neurological status and level of consciousness should be evaluated with aid of Glasgow coma scale to rule out any head injury. Chest and abdominal

examination should be done to rule out pulmonary or visceral injuries. Bladder should be catheterized to monitor urine output and bladder/urethral injury should be ruled out.

Spine examination is done after stabilizing the patient with minimal shifting of the patient. Log rolling procedure is done to roll the patient to his/her side for spine examination. [29]

Spine examination should include whole of the spine looking for tenderness to check multilevel spine fractures. Neurological assessment is done with ASIA scale. This includes testing motor power of ten muscles on each side of the body innervated by C5 to T1 and L2 to S1with pin prick assessment at 28 specific sensory dermatomes on each side of the body. The sum of motor and sensory score is calculated and compared with normal. Bulbocavernous reflex should be examined to check for spinal shock. Then rectal examination should be carried out to test the resting tone, voluntary contraction and perianal sensation. [30]

Neurological Evaluation

Frenkel scale (1969): [32]

A. Complete

B. Motor Complete, sensory incomplete

C. Motor useless

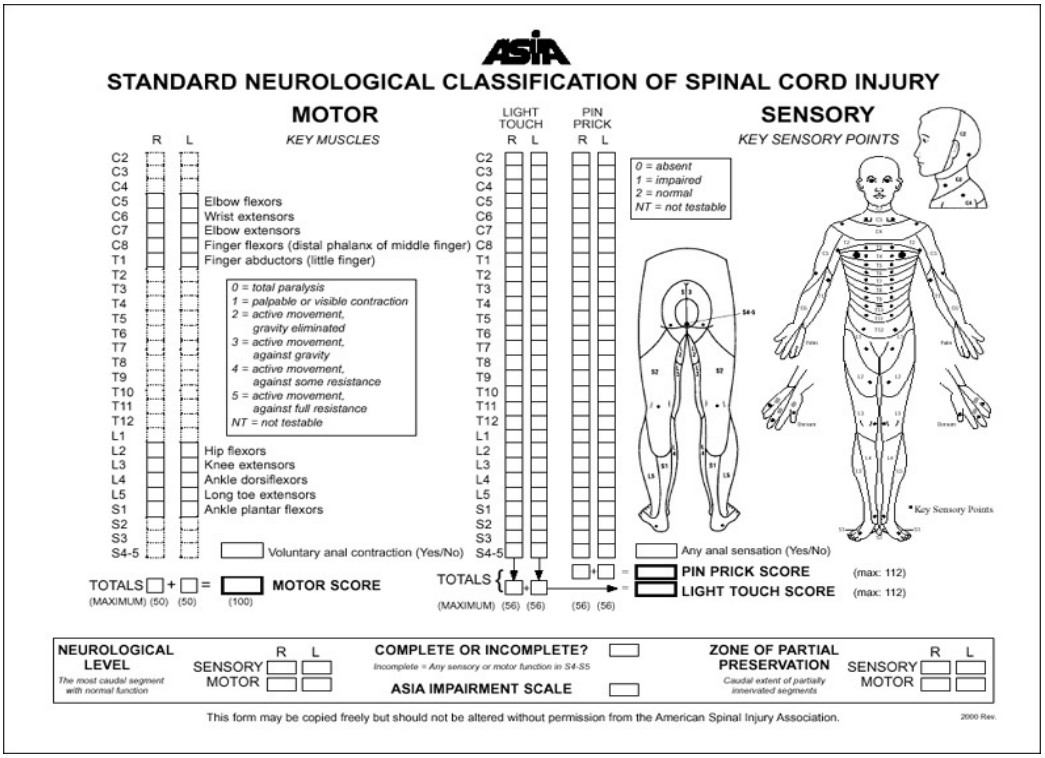
D. Motor Useful

E. Complete recovery

This classification was later modified by ASIA (American Spinal Injury Association) impairment scale (1992). Here, the complete injury is defined as the absence of sensory or motor functions in the lowest sacral segments and incomplete injury as preservation of motor and sensation below the neurological level of injury with sacral sparing.

ASIA Impairment Scale

A. Complete: No sensory or motor function is preserved in the sacral segments S4/S5.
B. Incomplete: Sensory, but not motor, function is preserved below the neurologic level extending through sacral segments S4/S5.
C. Incomplete: Motor function is preserved below the neurological level and more than half of key muscles below the level have a muscle grade of less than 3.
D. Incomplete : Motor function is preserved below the neurological level and more than half of key muscles below the level have a muscle grade greater than or equal to 3.
E. Normal: Recovery of motor or sensory function.



Sensory Examination

28 key dermatomes, each tested separately for pinprick and touch on a 3-point scale (0-absent, 1-impaired, 2-normal) is used with a face as the control point. Sensory index scoring is done by adding the scores for each dermatome. Maximum score is 112.

Motor Evaluation

Manual muscle testing grading system

Score Description

0- No movement

1- Palpable Contraction

2- Active movement with gravity elimination (Full range)

3- Active movement against gravity (Full range)

4- Active movement against moderate resistance (Full range)

5- Normal Strength

ASIA Motor Index Score

Is done on 10 key myotomes, by MMTG system and is calculated by adding the Muscles scores for each key muscle group. Total possible score is 100.

Myotome Key Muscles

C5 - Biceps

C6 -ECR

C7 -Triceps

C8 -Finger Flexors

T1 -Abductor Pollicis Brevis

L2 -Psoas

L3 -Quadriceps

L4 -Tibialis Anterior

L5 -EHL

S1 -Gastrosoleus

A muscle grade 3/5 and above is considered useful for A.D.L.

The Neurological level of injury on description takes into account both motor and sensory levels, i.e. most caudal level at which both motor and sensory modalities are intact.

INVESTIGATIONS

RADIOGRAPHIC EVALUATION

Radiographic evaluation is most simple and specific for the diagnosis of spinal injury. Anteroposterior and lateral views of spinal column are minimal mandatory views essential for spinal column injury evaluation. Spinal movement during radiographic evaluation should be kept minimum with an attending physician supervising the examination.

COMPUTED TOMOGRAPHY

In general CT scan is indicated for patients with suspected spinal fractures and dislocation that are not identified on plain radiographs and patients with incomplete visualization of the spinal column. Excellent bony detail of the fracture pattern can be obtained with CT scan.

MAGNETIC RESONANCE IMAGING

The MRI is indicated in every spinal cord injured patients to assess the status of the cord, disc and posterior ligamentous complex. It also detects the spinal cord edema and haematoma. Increased cord signals are associated with poor prognosis. The investigation of choice in spinal cord injuries is MRI.

REHABILITATION OUTCOME EVALUATION

Rehabilitation outcome evaluation involves assessment of individual functioning in various day to day activities. Assessing the self-care

activities assists in treatment, discharge planning by documenting current abilities and monitors changes in functional status.

Self care assessment tools

A number of functional assessment tools are available, for using in various conditions.

1. Pulses profile - by Moskowitz and Mc Cann 1957,

2. Katz index of Independence in ADL – granded A-G

3. The Barthel's index by Mathoney & Barthel (1965) – includes 10 items of ADL with a maximum score of 100.

4. The Kenny index of ADL (1960) – a five point scale from 0-4 with 17 ADL items.

5. Klien Bell ADL scale by Ronal Klein, and Beverly Bell – 170 items in six categories and a percentage score is computed.

6. Functional Independent Measure

FIM consists of 18 items organized into six categories, patients are assessed by 7 point ranging from complete independence value 7 and to complete dependence value-1 (self care, sphincter control, transfer, locomotion, communication, social cognition) is widely accepted and is a proven measure of ADL and social cognition.

7. Adult Needs Assessment Check List – includes 199 behavioural indicators assessing patient achievement in 9 core areas of rehabilitation.

REHABILITATION IN ACUTE PHASE

Manage of a patient with SCI starts at the site of injury. Trained personnel in dealing with SCI patient and unconscious patient have to adhere to the principles like positioning of patient, avoiding twisting movement of the spine, co-ordination among the members in shifting the patient.

Unconscious patients should be treated as spinal cord injured unless otherwise proved .Spine may be immobilized with cervical collar for cervical spine injury and two lateral sandbags and the patient strapped to the spinal board in thoraco-lumbar spine injury.

SURGICAL MANAGEMENT

TIMING OF SURGERY:

It is best to operate the patient as early as possible to aid early mobilization of the patient and to decrease hospital stay. In our institute MMC & RGGGH, surgery is done as per seniority status of patient.

IMPLANT OPTIONS

Implant options in the management of spine fractures include the following,

1. Posterior Instrumentation

Non segmental - Rod and hook system (Harrington rod)

Hybrid system - (Luque rod, Harrington rod with sublaminar wires) - these implants are not in use now.

Segmental system – Rod and hook constructs, Extended pedicle screw constructs,

Short segment pedicle instrumentation and Compression-Distraction instrumentation.

2. Anterior Instrumentation

Anterior plate, screw and rod instrumentation, anterior struts and cages.

Figure 1 Instruments used in Spine surgery

GOALS OF REHABILITATION IN ACUTE CARE

• Prevent pressure ulceration

• Maintain joint range of motion

• Begin bowel and bladder programs

• Begin sitting program

• Initiate activities of daily living appropriate to medical conditions.

REHABILITATION CONCERNS IN SPINAL CORD INJURY

1. Cardiovascular problems in spinal cord injury

Immediate problems includes cardiac arrhythmias and hemodynamic abnormalities , former being rare in chronic SCI. Cardiac problems are primary cause of death in these patients and magnitude of these problems depend on age, pre-existing cardiac morbidities, level of lesion and degree of immobilisation.

Major complications include thromboembolism and deep vein thrombosis (DVT), neurogenic orthostatic hypotension and autonomic dysreflexia. Thromboemolism and DVT can be prophylactically treated with heparin or LMW heparin, intermittent pneumatic compressions and thigh high stockings. Thigh as well as calf size and edema serve as indicators of DVT in SCI patients.

Orthostatic hypotension occurs in patients with lesion above T6 as baroreptors are lost and symptoms include light headedness, dizziness, weakness or even syncope. Elastic compression stockings, abdominal binder, adequate hydration and gradual change in positioning can be effective prophylaxis.

Autonomic dysreflexia are seen in SCI with lesion at or above T6 level and precipitating factors include bladder distension, fecal impaction and other noxious stimuli below the level of lesion. Immediate treatment

is provided to prevent intracranial haemorrhage. Blood pressure and pulse should be monitored frequently.

2. Respiratory problems in spinal cord injury

Respiratory complications are major cause of mortality and morbidity in SCI patients. In patients with lesion at T1 – T12, progressive loss of abdominal and intercostals motor function impairs coughing and breathing. Lesions at C4-C8 levels, there will be no intercostals or abdominal muscle activity leading to inadequate cough mechanisms. Partial diaphragmatic function is preserved in C4, C5 level lesions. Patients will be ventilator dependent in C3 and above. Acute treatment includes hypoxia management, minimising atelectasis and aspiration preventing pneumonia. Pulmonary toilette to clear secretions and tracheostomy should be performed in ventilator dependent patients to prevent subglottic and tracheal stenosis. Alternatively Intermittent positive Pressure Ventilation (IPPV), electrophrenic pacing can be tried.

3. Thromboembolic Disease

Thromboembolic disease estimates around 40% in patients with SCI without proper prophylaxis and develops deep venous thrombosis (DVT) during the acute phase. The risk factors of thromboembolism are venous stasis and hypercoagulability. DVT can present as fever of unknown origin and pulmonary embolism can result in sudden death.

The high incidence and unreliable presentation of DVT suggest that screening studies should be considered. A prophylactic strategy can address venous stasis and hypercoagulability. Pneumatic compression devices can be used for the first 2 weeks followed by use of a compression hose.

Figure 2 Prevention of orthostatic hypotension by tilting table monitoring

Unfractionated heparin (5000 U SC every 12 hours) or a low molecular weight heparin (30 mg SC every 24 hours), such as enoxaparin, can be administered following injury. [37]

4. Neuropathic Pain

Neuropathic pain following spinal cord injury (SCI) is perceived at or below the level of injury. Pain can be perceived as rest pain or from a stimulus that would, under normal conditions, not cause any pain (allodynia), or can be excessive in response to a painful stimulus (hyperalgesia).

Medical treatment includes the use of anticonvulsants and antidepressants. Gabapentin (initial dose of 100 mg PO tid, gradually titrated upward) typically is used with precautions for sedation. Tricyclic antidepressants may be useful for more constant diffuse pain. Amitriptyline (initial dose of 10 mg PO qhs, gradually titrated upward) is one of several agents. Precautions must be taken for its anticholinergic effects.

5. Neurogenic Bladder Dysfunction

Spinal cord injury (SCI) is followed by a period of bladder flaccidity. With injury above sacral levels, reflexes eventually return. These reflexes are unable to cause efficient voiding as reflex sphincter activity is opposed by reflex detrusor contraction. Isolation of the urinary tract apparatus from higher centres contribute to this problem called detrusor sphincter dyssynergy. Acute bladder management is by use of an indwelling catheter.

Long term management:

Patients require a socially acceptable drainage method and also to avoid skin wetting. Bladder emptying should be complete without high residual volumes. Storage and drainage of urine should occur under low intravesical pressure, as pressures over 40 cm of water, have been found to correlate with renal deterioration. Chronic use of an indwelling catheter is avoided as it can cause various soft tissue problems, renal problem and possibly bladder cancer.. Reflex bladder contractions can be inhibited by agents such as oxybutynin (5 mg PO tid) or tolterodine (2 mg PO bid).

Reflex voiding into a condom catheter is an option available to men with reflex bladder contractions. Ideal bladder management can avoid renal complications, however hydronephrosis and urinary tract calculi can occur. Annual surveillance of the urinary tract may detect subclinical problems and allow modification of the bladder regimen before significant complications occur.

6. Neurogenic Bowel Management

Neurogenic bowel dysfunction is a distressing and limiting impairment for a substantial proportion of spinal cord injury (SCI) individuals.Lower motor neuron dysfunction, cauda equina and conus medullaris syndrome causes constipation with slow colonic transport and incontinence due to a flaccid sphincter mechanism.

Upper motor neuron dysfunction also causes constipation with slow colonic transit and stool retention because of spasticity of the sphincter apparatus, but reflexes allowing defecation is functional.

Evaluation

Preparation of the patient

Trials of a specific bowel program

Adjustment of the program

Evaluation includes obtaining patient history, neurologic assessment, with examination of the bulbocavernosus and anocutaneous reflexes to differentiate upper or lower motor neuron bowel dysfunction.

Preparation of the patient includes education about the anticipated program.

The specific bowel program includes several measures. A typical problem is hard stool because of the prolonged colonic transport. Intervention includes adequate intake of fluid and fibre, with fibre acting as a sponge to hold moisture within the stool. Patients with lower motor neuron dysfunction may experience greater continence with stool than with upper motor neuron dysfunction.

A second problem is prolonged colonic transit time. Intervention includes maintenance of adequate stool bulk, which stimulates contractions of the colon. Fibre and bowel stimulant (eg, 2 senna tablets PO qid) can be effective.

With upper motor neuron injury, application of an irritant to the anorectal area, such as stimulation with a gloved finger or application of bisacodyl enema or suppository acts as trigger. With lower motor neuron bowel dysfunction, evacuation by use of the Valsalva maneuver and digital removal are helpful.

7. Heterotopic ossification

Heterotopic ossification (HO) is the formation of new bone in soft tissue planes surrounding a joint in SCI patients, hip being common. Presentation include generalized or localized lower extremity swelling, loss of hip range of motion (ROM), fever, and elevated alkaline phosphatase level.

Laboratory examination includes serum alkaline phosphatase, radiography and bone scan. Loss of hip ROM complicates bed and chair positioning and can make dressing and bathing difficult. Measures to limit the eventual amount of bone mass formed include use of Etidronate (20 mg/kg/day PO for 2 wk, followed by 10 mg/kg/day for at least 10 wk), non steroidal anti inflammatory drugs (NSAIDs)- Indomethacin (25 mg PO tid), and irradiation. Severe loss of ROM can be treated surgically.

8. Pressure Ulceration

Pressure ulceration is the most common complications of spinal cord injury (SCI), along with urinary tract infections accounting 25% of annual incidence in chronic SCI. Pressure to soft tissue exceeding capillary pressure is the principal cause of skin breakdown. Shear can distort interposed blood vessels leading to tissue breakdown. Evaluation includes an assessment of the ulcer's depth.

The most widely accepted classification is,

National pressure ulcer advisory panel (NPUAP) Classification:

Stage I: Non blanchable erythema not resolved in 30min

Stage II: Partial – thickness loss of skin involving epidermis – possibly into dermis

Stage III: Full thickness destruction through dermis into subcutaneous tissue

Stage IV: Deep tissue destruction through subcutaneous tissue to fascia, muscle, bone or joint.

Prophylaxis involves minimising the amount of pressure and the time over which pressure is applied. Weight shifting while in a wheelchair and turning in bed reduce the time of exposure to pressure. Alpha beds alternately inflated and deflated avoid exposure that is prolonged enough to damage tissue.

Treatment of an established ulcer involves limiting or eliminating pressure to the area confining a person with an ischial ulcer to bed rest. Local care includes necrotic tissue removal by sharp debridement and by topical enzymatic debriding agents, normal saline solution is used for cleansing. Topical antibiotics are used only for foul wounds. Healing can be delayed in the absence of proper nutrition, including adequate provision of calories, protein, vitamin C, and zinc. [39] Smoking slows healing. Deep ulcers can be treated surgically with debridement and repair by myocutaneous flap. Surgery is best deferred until nutritional status is adequate. Postsurgical care is prolonged and crucial.

Figure 3 Pressure sore

Figure 4 Pressure sore treated with rotational flap cover

9. Spasticity

Velocity dependent increase in muscle tone and occurs commonly following spinal cord injury (SCI) and other types of upper motor neuron injury Spasticity causes resistance to passive motion of the limbs, exaggerated deep tendon reflexes, clonus, and involuntary contraction of muscle groups[40]. Spasticity has desirable and undesirable effects. Spasticity helps to assist with mobility, especially by those with incomplete injuries and can improve circulation and may be useful for decreasing the risk of deep venous thrombosis and osteoporosis. On the other hand, spasticity can interfere with positioning, mobility, and hygiene, and spasms can be painful.

The mainstay of treatment is the elimination of exacerbating factors and regular muscle stretching. Interventions to reduce spasticity are as follows:

-Prevention and treatment of noxious stimuli (eg, pressure ulcer, urinary tract infection, urinary tract stone, ingrown toenail)

-Regular muscle stretching and joint range of motion

-Oral medication

-Botulinum toxin injection (useful for treatment of problems caused by specific muscle groups)

-Intrathecal baclofen delivered by an implanted pump

-Peripheral procedures, including neurolysis and contracture release

-Central ablative procedures, such as rhizotomy and myelotomy

Figure 5 Walking on parallel bar

COMMUNITY & DOMICILIARY REHABILITATION

Residence

Reintegration into society is the goal of rehabilitation in SCI patients and patients are discharged to their private residences after rehabilitation. These patients need household modifications for their unrestricted mobilisation. Household modifications like even terrain, toilet modifications and large doorway and ramps for wheel chair mobility are necessary. This adds to the burden for these individuals and house hold modifications are less carried out.

Marriage

There has an increased rate of separation and divorce for SCI patients who were married at time of injury and rate of marriage in patients after injury is low when compared to general population owing to poverty and stigma in social population. “Nearly 90% of those single at the time of SCI are still single 5 years following injury, compared with an expected rate of 65% in the absence of SCI”.

Employment and education

“As a group, those with quadriplegia achieve a higher educational level than those with paraplegia, and those with complete injuries reach a higher level than those with incomplete injuries”. The rate of education is

lower than general population after the injury and rate of employment also decreases following SCI. While young age at time of injury has greater chances of further education.

Sexual Physiology

Management of erectile dysfunction –Sildenafil has been found to be effective in both UMN and LMN lesions. It can increase the erectile function, but should not be used in patients on treatment with nitrates. Intracavernosal injection of papaverine or prostaglandin E1 can also be used. In women, capacity for orgasm is retained following SCI and vaginal vasocongestion can occur in response to local stimulation. However, women with injuries above T6, vaginal vasocongestion in response to psychogenic stimulation alone does not occur as isolation of the brain from the sympathetic outflow to the genitals.

Fertility

Men are infertile following SCI as coordination of events causing ejaculation, including seminal emission, bladder neck closure, and perineal muscle contraction, is disrupted. Ejaculation can be induced by external vibratory stimulation. This involves the use of a vibrator over the glans and frenulum to induce an ejaculatory reflex. Semen can be used for in vitro fertilization. In women, a period of amenorrhoea is experienced after SCI, and can be reversed with intervention. Pregnancy

in SCI is considered high risk and as they cannot sense usual indicators of labour, unattended preterm delivery can occur.

Psychological Adjustment and Life Satisfaction

Significant depression occurs in SCI patients which may require intervention. Increased risk of suicide is reported in SCI patients in years immediately following injury and the rate comes to the level of general population after 10 years.Quality of life following SCI is influenced mainly by the degree of incorporation of patients into the society rather than neurological status.

"To measure the association between mode of locomotion well as locomotion independence, and health, participation, and wellbeing in patients with SCIs, Krause et al analyzed survey data of 1493 rehabilitation patients 18 years of age or older who had had an SCI for at least 1 year and found out that there were small but significant associations between independence in locomotion and each measure." Patients independent on wheel chairs had better outcomes than non wheel chair users.

REHABILITAION TEAM AND THEIR ROLES

Physiatrist

The Physiatrist is the leader of rehabilitation team. The physical medicine specialist or physiatrist is qualified in evaluation of functional

impairment, prescription of physiotherapy, occupational therapy program, orthoses and prostheses and psychosocial rehabilitation. Their main role is to clinically assess the patient and coordinate with other members of rehabilitation team and chart out the line of management.

Rehabilitation Nurse

Proper positioning, avoidance of pressure ulceration, bladder and bowel care and identifying the needs of the patient is the mainstay of management in acute phase. Nurses are people who spend more time with the patient than any other member of the rehabilitation and they are responsible for providing these acute phase care.

Physiotherapist

Their services are also required from acute stage.

Acute stage or immobilization stage:

Passive or active range of motion exercises, conditioning exercise to upper limbs to avoid the negative effects of immobilization and chest physiotherapy to avoid stasis.

Convalescent stage

Physiotherapist now encounters complications like pressure ulceration, spasticity, orthostatic hypotension and occasionally autonomous dysreflexia. Relaxation exercises, tilt tabling and associated upper limb and trunk crutch muscles strengthening program are given. Bed mobility, transfers, wheel chair mobility, ambulation including

climbing stairs and negotiating uneven surfaces is assessed. Depending upon the level of lesion, the following gait expectations are possible in complete paraplegia.

Cervical cord lesions – Wheel chair ambulation

T1 →T10 cord lesions – Therapeutic standing

T11 →L1 cord lesions – Household ambulation

Below L1 lesions - Community ambulation

During chronic stage – physiotherapist teaches a home program regarding skin care, prevention of contractures, ROM exercises, strengthening exercises and reviews the patient periodically once a month.

Orthotic and Prosthetic Technician

Ambulation in paraplegics is either wheel chair or walking braces depending upon the level of neurological deficit. For lesions from T1 - T10, bracing the patient completely is necessary– long leg braces with spinal extension allows them to stand, which avoids the complications of recumbencey as well as psychologically boosts the patient.

For lesion from T11to L1 where there is truncal stability and partial preservation of ability to hike and rotate pelvis – long leg braces with pelvis support (if no sensory loss) can be prescribed. Gait will be initially 'swing to' gait and later 'swing through' gait using upper limb musculature.

Lesion below L2 with preservation of the quadratus lumborum and ability to swing forward, bracing now depends on the residual power of the limb Recommendation for complete paraplegia patient

Bilateral KAFO, Knee joint with drop lock with no knee cap but with upper and lower knee pad, with 10º fixed dorsiflexion of ankle with boot with microcellular rubber insole with shoe upper part lined by soft sewn leather.

By virtue of 10º fixed dorsiflexion, during foot flat stage, body leans forward and patient arches the spine backward to adjust his centre of gravity. In this process the stronger ilio-femoral ligament prevents hyperextension by supporting the hip and hence patient does not fall backwards. Knees and ankles are supported by braces.MCR and other modifications in the shoes are for the sensory deficit to avoid subtle injury.

MATERIALS AND METHODS

Our study was a prospective cum retrospective study, conducted at the Institute of Orthopaedics and Traumatology, Madras Medical College and Rajiv Gandhi Government General Hospital, Chennai from April 2016 to August 2016 involving 40 patients.

INCLUSION CRITERIA

I) New onset traumatic spinal cord lesion

II) Spinal cord injury patients with neurological deficit (ASIA scale A-D)

III) Any level of spine injury

IV) Traumatic cauda equina syndrome

V) Patients with follow up period of minimum three months

EXCLUSION CRITERIA

I) Brain related paraplegia

II) Neurological impairment due to isolated peripheral nervous lesions

III) Neurological impairment due to disease (vascular, inflammatory, tumour etc) or surgery for non traumatic pathology

IV) Patients without neurological deficit and follow up period of less than 3 months were excluded Age, sex, nationality, mode of injury, existing pathologies and injuries related to the spinal cord lesions are not criteria for exclusion.

METHODOLOGY

Forty patients who presented with spinal fractures to our Institute of Orthopaedics and Traumatology were included in our study. Mode of transportation of patients and time delay to admission were studied. All patients were resuscitated appropriately. A complete clinical and neurological examination was done for all the patients. The American Spinal Injury Association (ASIA) scale was used for neurological evaluation and grading done with Frankel Grading scale. All patients were taken radiographs of cervical, dorsal, lumbosacral spine both Antero-posterior and lateral views. Pelvis with both hips AP view is also taken for all patients to rule out associated pelvic fractures. CT and MRI of spine were taken. On admission, catheterisation of bladder was done with Foleys catheter and patients were transferred to alpha bed/water beds. Log rolling was encouraged for every two hours to prevent pressure ulcers.

The mode of injury, percent of anterior vertebral body compression, angle of deformity, and displacement percentage were determined for all levels of injury. The unstable fractures were defined by

clinical and radiological parameters. They include burst fractures with any one of the following criteria,

a. Neurological deficit
b. More than 50 % axial compression
c. More than 25 % angulation
d. Wedge compression fractures involving middle column with neurological deficit and fracture dislocations with neurological deficit. The treatment was planned accordingly.

SURGICAL MANAGEMENT

Patients with unstable thoracolumbar spine injuries were surgically stabilised with instrumented posterior stabilisation and decompression was done for patients with spinal cord compression.

Patients diagnosed with unstable cervical spine injuries were surgically treated with anterior stabilisation and fusion with either bone graft or cage. Patients with traumatic disc disease were treated with disectomy and stabilisation with anterior cervical locking plate.

POSTOPERATIVE MANAGEMENT

All the patients were turned sideways periodically in the immediate post operative period and use of alpha bed /water bed was continued. In case of cervical spine surgery, Philadelphia collar was applied to the patient post operatively and Ryle's tube feeding was started after bowel sounds recovered. Ryle's tube feeding was continued till

patient was able to swallow. Suction drainage was removed at 48 hours. Indwelling bladder catheter was continued in post operative period and return of bladder sensation was monitored. Catheter was changed every 15 days. They were allowed to sit after wearing a Taylor's brace or Philadelphia collar with a back support on 10th post operative day or more depending on the pain tolerance of the patient. Suture removal was done on 12th post operative day. Active assisted and passive exercises were taught to keep the joints supple. After suture removal, patients were referred to Government Institute of Rehabilitation Medicine, KK Nagar for comprehensive rehabilitation.

REHABILITATION PROTOCOL

Rehabilitation protocol was aimed at improving functional outcome and preventing complications. Patients functional outcome were assessed with functional independent measure [FIM] score which included 18 items organized into six categories, patients were assessed by 7 point ranging from complete independence value 7, to complete dependence value-1 (self care, sphincter control, transfer, locomotion, communication, social cognition) at the time of admission, discharge and follow-up.

Bowel and Bladder rehabilitation protocol:

The bladder rehabilitation in our rehabilitation centre was aimed at resumption of balanced bladder by providing clean intermittent

bladder catheterisation (ICC), either by self or by care givers. Two essentials for a trial of intermittent catheterisation are a large volume of residual urine and a motivated patient or carer. Excessive residual urine implies adequate bladder capacity and sphincter activity. Timely voiding 4-5 times a day with low residual volume of <50 ml was the goal of ICC. Condom catheter was provided during sleep and mobilisation for these patients. Patients with absent bladder sensation, dribbling bladder and unable to perform intermittent catheterisation were managed with indwelling Foley's catheter which was changed for every 15 days. Patients who were able to initiate voiding reflex were managed with reflex or induced voiding. Suprapubic catheterisation was performed in patients with compromised urethral passage. Bladder wash was provided with betadine and normal saline in ratio 1:5 for patients with turbid urine and catheter block.

The end point of bowel rehabilitation in our institute was timely bowel evacuation with no constipation for more than 48hours. Patients were encouraged to take timely dinner and evacuation was initiated next morning by utilising intact gastrocolic reflex. In patients with UMN lesions, evacuation was done by reflex evacuation while in LMN lesions, digital evacuation was done.

Ambulation protocol:

In our institute, functional rehabilitation was aimed at restoration of locomotor ability. Locomotor ability in these patients are categorised into limited indoor ambulation, limited outdoor ambulation and community ambulation. Patients with quadriplegia were rehabilitated to use wheel chair ambulation with self propulsion of wheel chair or by care givers. Patients with incomplete neurological deficit were ambulated based on Ambulation Motor Index (AMI) which included assessment of sum of five lower extremity muscle grades. Maximum score of 3 is provided to each muscle group with total score of 30. Postural stability exercises were taught to these patients.

In paraplegia patients, ambulation ability was provided depending on level of lesion and level of intact muscle power. Patients with truncal stability were provided with HKAFO, in patients with useful power of hip group of muscles KAFO were prescribed and with intact knee group of muscles AFO were prescribed. Assisting devices like crutches and walker were provided.

Patients who were immobilised for long periods were given tilt table monitoring for prevention of orthostatic hypotension, atleast five times a day.

- **Functional Independence Measure(FIM) Score**
- 7 Complete independence NO HELPER (timely, safely)

- 6 Modified independence (devices)
- Modified dependence HELPER
- 5 Supervisor (subject =100%)
- 4 Minimal assist (subject =76%+)
- 3 Moderate assist (subject = 50%+)
- Complete dependence
- 2 Maximal assist (subject =25%+)
- 1 Total assist (subject = or less than 25%)

Components included in FIM

- **1]Self Care**
- Eating
- Grooming
- Bathing
- Dressing – upper body
- Dressing – lower body
- Toileting
- **2]Sphincter control**
- Bladder management
- Bowel management
- **3]Transfer**
- Bed, Chair, Wheelchair
- Toilet

- Tub, shower
- **4]Locomotion**
- Walk, Wheelchair
- Stairs
- **5]Motor Subtotal score**
- **6]Communication**
- Comprehension
- Expression
- Social Cognition
- Social interaction
- Problem solving
- Memory
- **7]Cognitive subtotal score**

  Maximum score is 126.

Ambulation motor index (AMI)

Sum of five lower extremity muscle grades

MUSCLE GROUPS	MAXIMUM SCORE	
	RIGHT	LEFT
Hip flexors	3	3
Hip extensors	3	
Hip abductors	3	3
Knee flexors	3	3
Knee extensors	3	3

Maximum score amounts to 30 and percentage of this score gives the AMI.

OBSERVATION AND RESULTS

The following observations were made in the study.

1. **Distribution of study sample according to level of lesion**

In our study, level of lesion were maximum in lower thoracic level (D7-D12) contributing 45% of our study and upper thoracic region (D1-D6) had least incidence of injury.

Level of lesion	**Number of subjects**	**percentage**
Cervical spine	11	27.5
Upper thoracic spine [D1-D6]	2	5
Lower thoracic spine [D7-D12]	18	45
Lumbar spine	9	22.5
Total	**40**	**100**

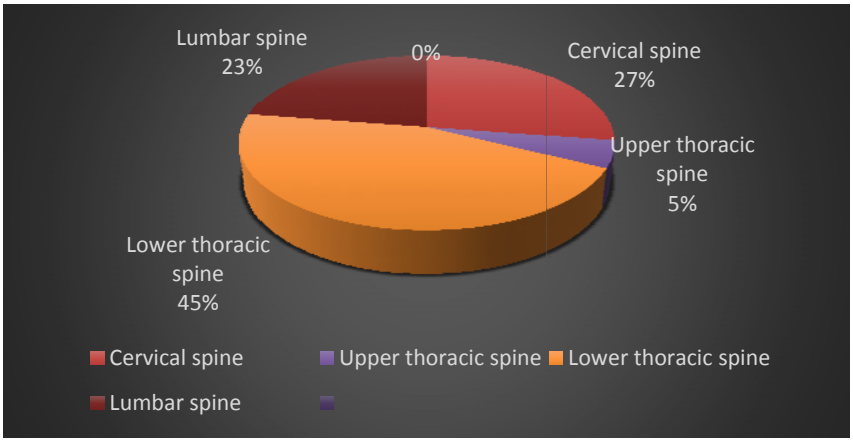


Figure 1. Distribution of study sample according to level of lesion

2. Distribution of study subjects according to their age group and level of lesion (N=40)

In our study, highest incidences were among the age groups of 20-40 and age groups of <20 years were having least incidence.

Age group	Cervical spine	Upper thoracic spine	Lower thoracic spine	Lumbar spine
<20	0	0	0	2 (22.2%)
20-40	7 (63.6%)	2 (100%)	12 (66.7%)	4 (44.4%)
40-60	4 (36.4%)	0	4 (22.2%)	2 (22.2%)
>60	0	0	2 (11.1%)	1 (11.1%)
Total	11 (100%)	2 (100%)	18 (100%)	9 (100%)

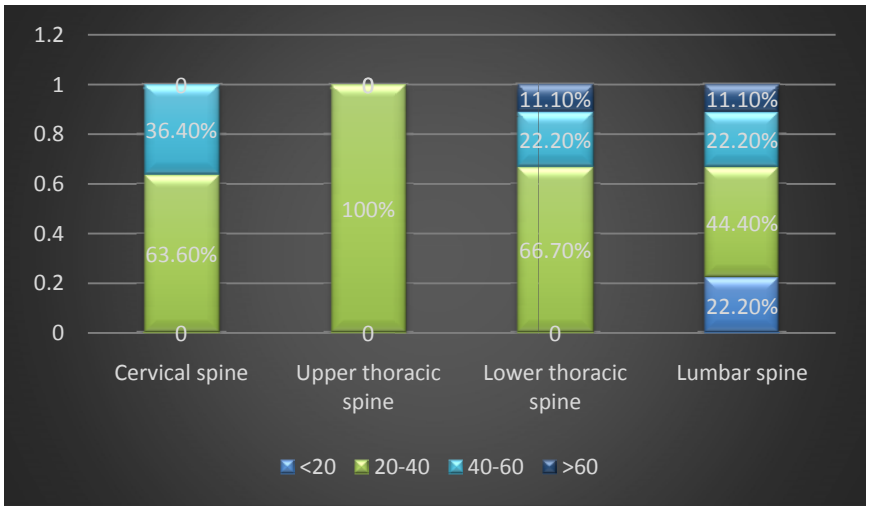


Figure 2.Distribution of study subjects according to their age group and level of lesion

3. **Distribution of study subjects according to their gender and level of** lesion (N=40)

Incidences of SCI were most common among males in our study.

Gender	Cervical spine	Upper thoracic	Lower thoracic	Lumbar
Male	10 (90.9%)	2 (100%)	14 (77.8%)	6 (66.7%)
Female	1(9.1%)	0	4 (22.2%)	3 (33.3%)
Total	11 (100%)	2 (100%)	18 (100%)	9 (100%)

4. Mode of transportation:

In our study, ideal transportation in an ambulance was carried out in 13 patients, while 27 patients were carried manually in other modes of transportation like car, bike etc.

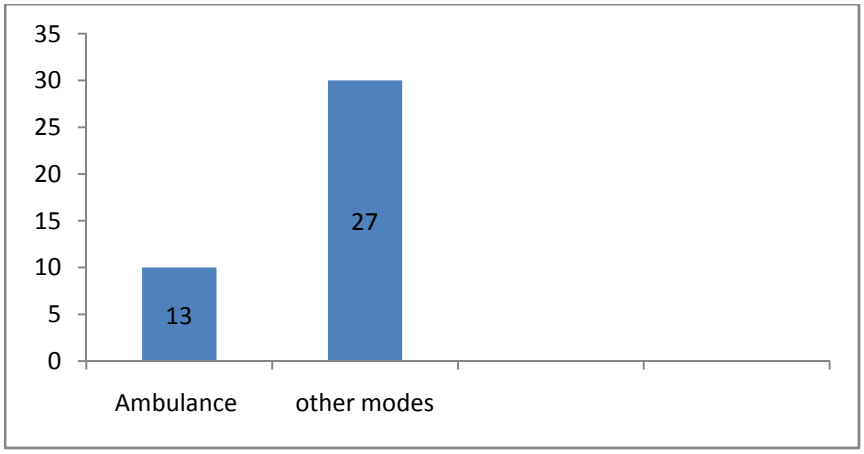


Figure 3.Distribution of study subjects according to mode of transportation

5. Distribution of study subjects according to the place of injury (N=40)

In our study, SCI occurred in urban and semiurban areas in 28 patients while injury in 12 patients occurred in rural places. Majority of injuries were due to fall from height in both urban and rural places

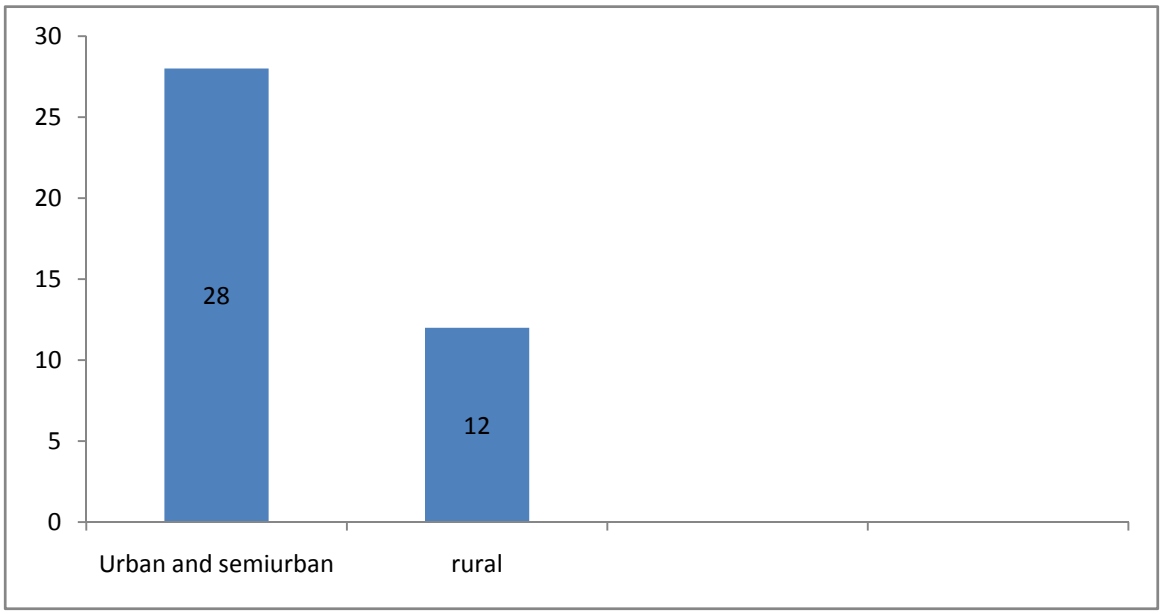
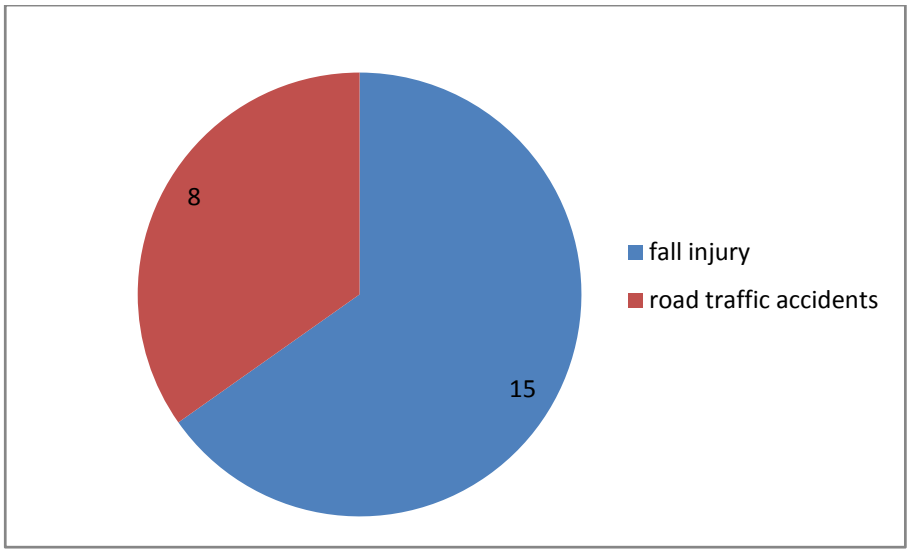


Figure 4.Distribution of study subjects according to place of injury

Urban & semi urban population:



6. Distribution of study subjects according to level of education (N=40):

Out of 40 patients included in our study, 8 patients who were injured had completed/pursuing their post graduation, 6 patients completed /pursuing under graduation , 22 patients were of primary education status and 4 patients were illiterate.

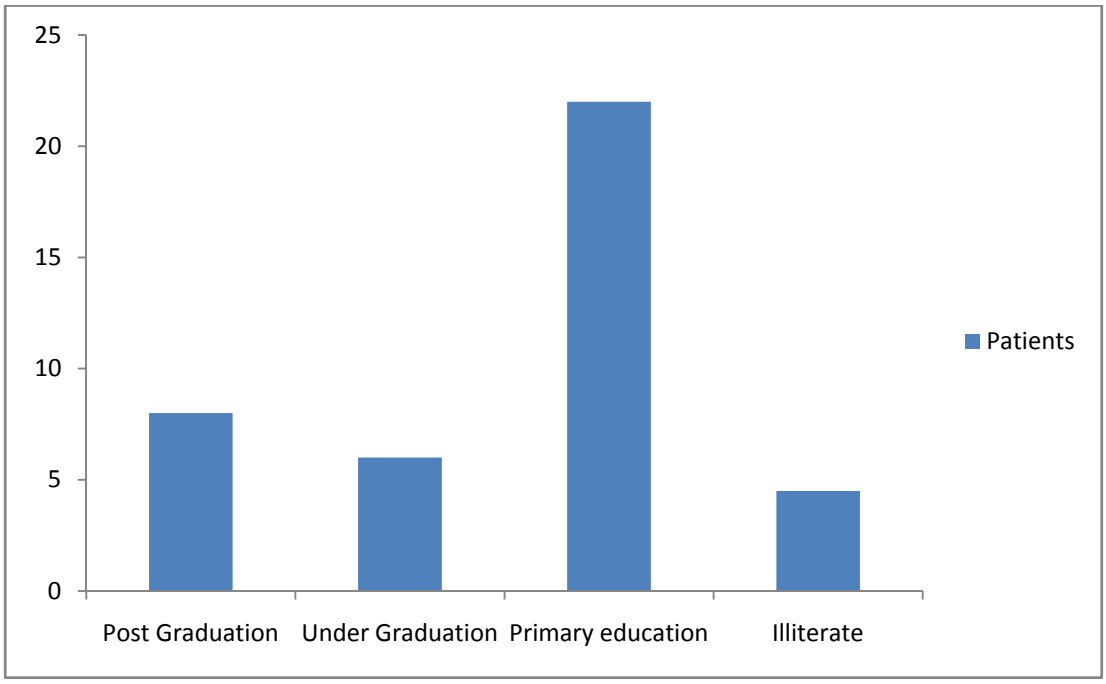


Figure 5.Distribution of study subjects according to their level of education

7. Distribution of study subjects according to pre-injury occupation (N=40):

Our study found out that patients were occupied as

Professional- 3

Agriculture- 3

Skilled- 7

Unskilled- 19

Unemployed- 8

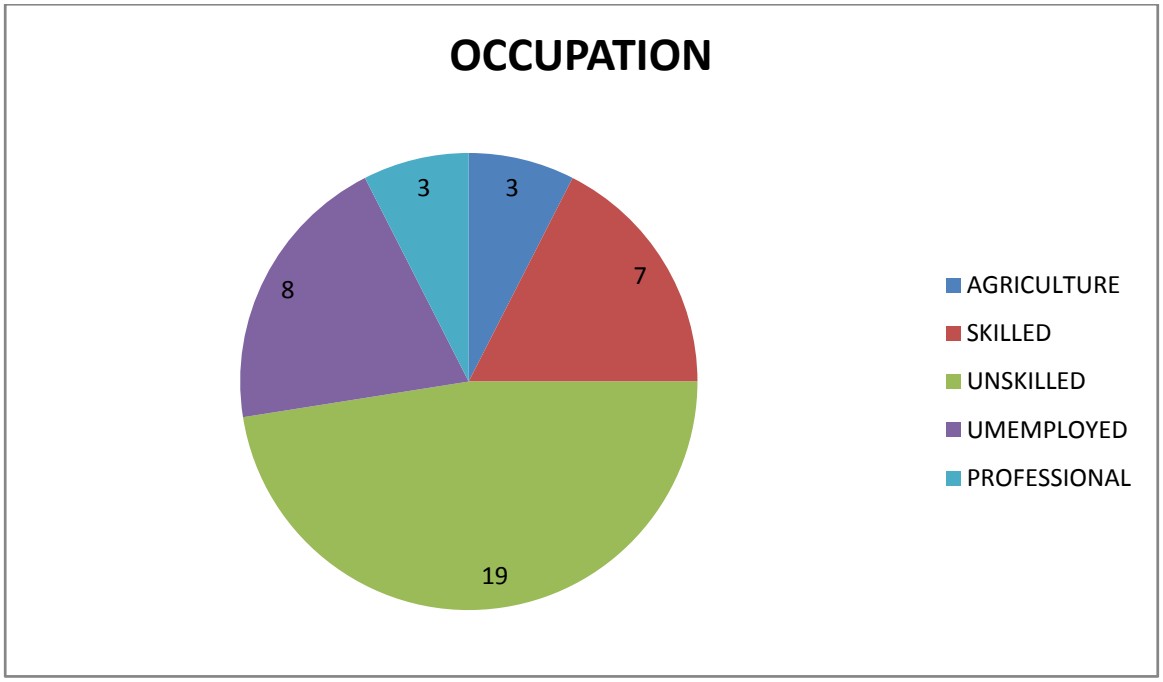


Figure 6.Distribution of study subjects according to their occupation

8. Distribution of study subjects according to income (N=40):

At time of injury, 60% of patient's average monthly income were around Rs less than Rs 5000 and at follow up, 69% of patients were unable to support themselves or their family financially.

9. Distribution of study subjects according to marital status of patients (N=40):

In our study, 19 patients were married at time of injury and rest were unmarried. At follow up, no patients married after injury and rest were supported / taken care by their spouses.

10 . Distribution of study subjects according to time lag between injury and hospital admission (N=40):

In our study, the average delay in injury and first admission in hospital was 16 hours. 15 patients were admitted in tertiary centre within 8 hours of injury while others were admitted with delay of more than 8 hours.

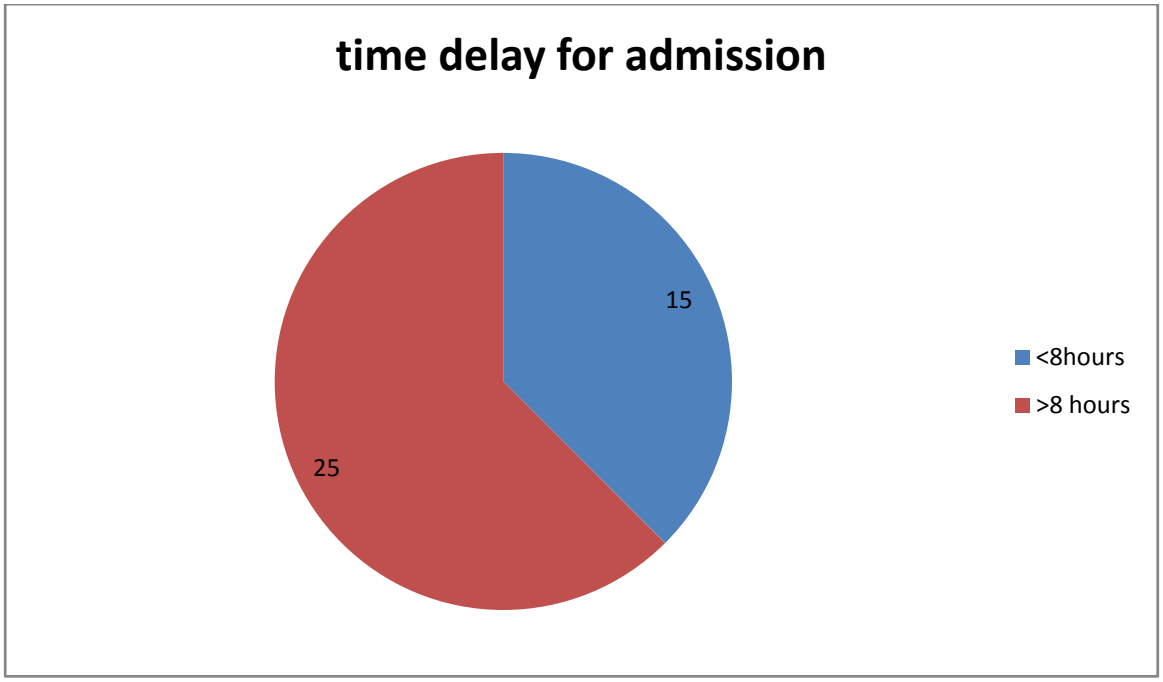


Figure 7.Distribution of study subjects according to time delay for admission

11. Distribution of study subjects according to mode of injury and level of lesion (n=40)

Fall from height contributed to most injuries and were the most common cause followed by road traffic accidents.

Mode of injury	Cervical spine	Upper thoracic	Lower thoracic	Lumbar
RTA	7	1	5	2
FOH	4	1	13	7
Total	11	2	18	9

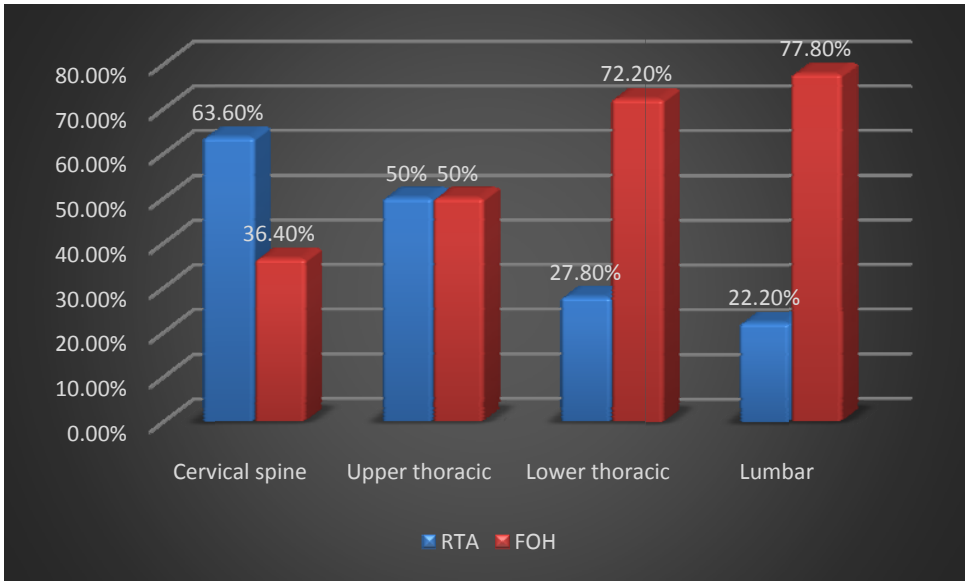


Figure 8. Distribution of study subjects according to mode of injury and level of lesion

12. Distribution of study subjects according to preoperative neurological lesion and level of lesion (N=40)

Complete neurological deficit accounted for majority of SCI patients at presentation amounting to 27 patients and most common with lower thoracic injury. Incomplete deficits were accounted in 13 patients.

Preoperative neurological lesion	Cervical spine	Upper thoracic spine	Lower thoracic spine	Lumbar spine
Paraplegia	1 (9.1%)	2 (100%)	16 (88.9%)	7 (77.8%)
Paraparesis	0(0)	0	2 (11.1%)	2 (22.2%)
Quadriplegia	1 (9.1%)	0	0	0
Quadriparesis	9 (81.8%)	0	0	0
Total	11 (100%)	2 (100%)	18 (100%)	9 (100%)

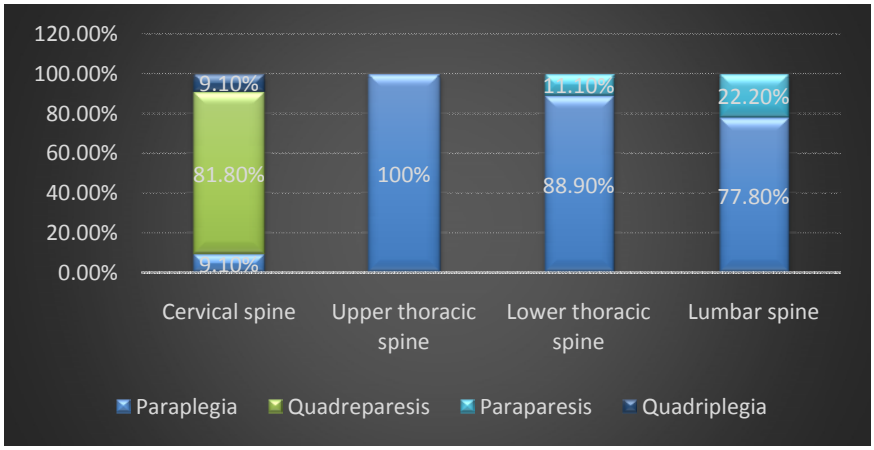


Figure 9. Distribution of study subjects according to preoperative neurological lesion and level of lesion

13. Distribution of study subjects according to level of lesion and associated injuries (N=40)

In our study, patients with lower thoracic spine injury accounted for most associated injuries and calcaneum fractures accounted for most common associated injuries.26 patients had no associated injuries

Associated injuries	Cervical spine	Upper thoracic spine	Lower thoracic spine	Lumbar spine
No injuries	9	0	10	7
Transverse process #	0	0	1	0
Spinous process #	0	0	2	0
SPR,IPR#, Iliac wing #, Sacra ala #	0	0	0	1
Shaft of femur#& Electric Burns	0	0	1	0
Proximal Tibia #	0	0	0	1
#shaft of fibula Lt	0	0	1	0
B/L calcaneal #	0	0	1	1

Ribs# & Scapula #	0	1	1	0
#Shaft of humerus	1 (9.1%)	0	0	0
Radial & Ulnar Styloid #	1	0	0	0
Distal radius #	0	0	1	0

14. Distribution of study subjects according to level of lesion and treatment (N=40)

In our study, only two out of forty patients were treated conservatively due to severe medical comorbidities. In 11 cervical spine injury patients, corpectomy and fusion were done in 6 patients, remaining 4 patients were treated with disectomy and stabilisation and one patient was treated with laminectomy and decompression.

In patients with thoracolumbar injuries, 18 patients were treated with posterior instrumented stabilization and decompression, while 9 patients were treated with posterior instrumented stabilization alone.

Treatment given	Cervical spine	Upper thoracic spine	Lower thoracic spine	Lumbar spine
Posterior instrumented stabilisation	0	0	8	1
Posterior Instrumented stabilisation& decompression	0	1	10	7
Corpectomy& fusion & bone graft	3	0	0	0
Conservative	0	1	0	1
ACDF with cervical plate	3	0	0	0
Corpectomy& cage fixation	3	0	0	0
ACDF&Bone grafting	1	0	0	0
Laminectomy & decompression	1	0	0	0
Total	11	2	18	9

15. Distribution of study subjects according to level of lesion and ASIA scale (N=40)

In our study, ASIA A category comprised majority of patients 19 patients and most cases (13 of them) were in patients with lower thoracic spine injury patients.

ASIA scale	Cervical spine	Upper thoracic spine	Lower thoracic spine	Lumbar spine
A	1	2	13	3
B	1	0	0	0
C	6	0	3	6
D	3	0	2	0
Total	11	2	18	9

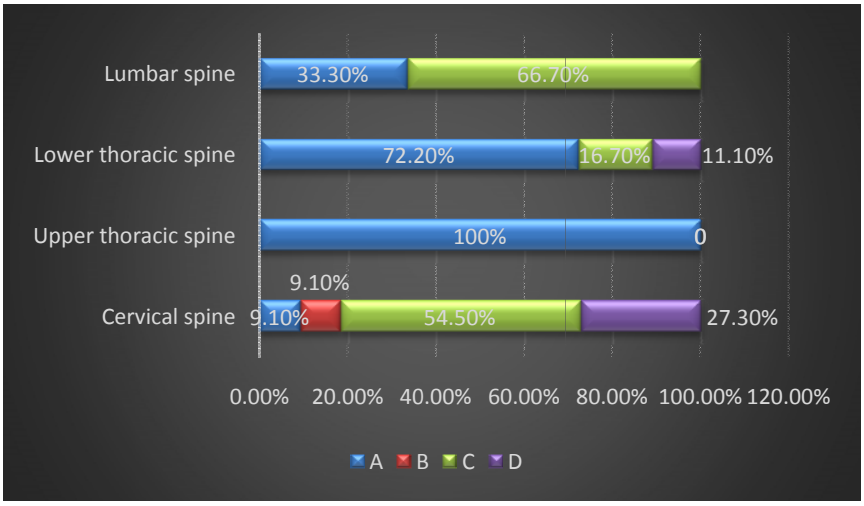


Figure 10. Distribution of study subjects according to level of lesion and ASIA scale

16. Distribution of study population according to level of lesion and time lag to surgery (N=40)

In our study, average time lag for surgery was 22.4 days with maximum being 60 days and minimum of 2 days.

Level of lesion	Mean duration of surgery (in days)	Standard deviation	Minimum	Maximum
Cervical spine	28.91	15.6	10	60
Upper thoracic spine	8		8	8
Lower thoracic spine	18.50	15.70	2	60
Lumbar spine	24	8.60	8	36

17. Distribution of study population according to level of lesion and duration of follow up(N=40)

In our study, mean duration of follow up were 15 months in cervical spine patients, 12 months in upper thoracic spine, 13.9 months in lower thoracic spine patients and 13.11 months in lumbar spine. Maximum duration of follow up was 36 months.

Level of lesion	Mean duration of follow up (in months)	Standard deviation	Minimum	Maximum
Cervical spine	15.64	7.42	5	30
Upper thoracic spine	12	11.314	4	20
Lower thoracic spine	13.9	10.34	4	36
Lumbar spine	13.11	11.12	3	36

18. Distribution of study population according to level of lesion and mean duration of rehabilitation(N=40)

Average duration of rehabilitation was 99.8 days and table shows duration of rehabilitation in each group. Patients with cervical spine injury were having maximum duration of rehabilitation.

Level of lesion	Mean duration of rehabilitation (in months)	Standard deviation	Minimum	Maximum
Cervical spine	4	1.34	2	7
Upper thoracic spine	2.5	0.71	2	3
Lower thoracic spine	2.94	1.35	1	6
Lumbar spine	3.44	0.73	2	4

19. Distribution of study population according to level of lesion and complication(N=40)

In our study, main complications we encountered were pressure ulceration and urinary tract infections accounting for 57% and 37% respectively.

Other Complications include joint stiffness, spasticity, equinus deformity, heterotopic ossification, deep vein thrombosis.

10 patients out of 40 patients had no complications.

Complications	No of patients
Pressure ulcer	23
UTI	15
CKD	1
DVT	1
Heterotropic ossification	1
Ankle equinus	3
Joint stiffness	2
Post op infection	2
Implant failure	1

20. Distribution of study subjects according to level of lesion and mobility outcome(N=40)

Only two out of forty patients showed no improvement in mobility after rehabilitation. Significant numbers of patients in cervical and lumbar level of injuries were rehabilitated as community ambulators. Majority of patients showed improvement in ambulation.

Mobility outcome	Cervical spine	Upper thoracic spine	Lower thoracic spine	Lumbar spine
Bed mobility	1	0	1	0
Wheel Chair Mobility	0	1	7	3
Limited indoor mobility	2	0	0	0
Limited outdoor mobility	3	1	7	3
Community ambulatory	5	0	3	3
Total	**11**	**2**	**18**	**9**

21. Distribution of study subjects according to their mode of ambulation (N=40)

Mode of ambulation	Cervical spine	Upper thoracic spine	Lower thoracic spine	Lumbar spine
Bed mobility	1	0	1	0
Wheel chair mobility	0	1	7	3
Standing with HKAFO and spinal support	2	0	0	0
Walking with B/L HKAFO with walkers	0	1	5	1
Walking with B/L HKAFO with crutches	0	0	0	2
HKAFO orthrosis and walker	2	0	1	0
B/L KAFO with walker	0	0	1	0
B/L posterior tube splint with walker support	1	0	0	0
Walking with AFO And crutches	0	0	1	1
Walking with AFO and walker	1	0	0	1
Walking with B/L AFO	0	0	1	0
Walking with walker,without orthosis	1	0	0	1
B/L elbow crutches	0	0	1	0
Walking with crutches	2	0	0	0
Without support	1	0	0	
Total	11	2	18	9

22. Average gain in FIM score according to ASIA scale(N=40)

Level of lesion	ASIA scale (No. of subjects)	Average gain in FIM score	Standard Error	F value	P value
Cervical spine	A (1)	15	-	5.293	**0.032 (Significant)**
	B (1)	20	-		
	C (6)	12.83	2.48		
	D (3)	28.33	2.33		
Lower thoracic spine	A (13)	12.15	1.07	0.940	**0.412 (Significant)**
	B(0)	-			
	C(3)	14.67	3.48		
	D (2)	16	4		
Lumbar spine	A(3)	11.33	2.90	0.447	**0.525 (Significant)**
	B (0)	-	-		
	C (6)	14	2.39		
	D (0)	-	-		

Average gain in FIM score was higher among cervical spine injury patient with ASIA scale D compare to other groups which was found to be statistically significant with F value of 5.293 and p value of 0.032.

23. Association between average gain of FIM score and level of lesion (N=40)

Level of lesion (No. of subjects)	Mean FIM score during admission	Mean FIM score during follow up	Average gain in FIM score	Standard Error of Mean	t-value	p-value
Cervical spine (11)	59.91	77.82	17.909	2.542	7.045	**<0.01 Significant**
Upper thoracic spine (2)	56	84	28	13	2.154	**0.277**
Lower thoracic spine (18)	63.33	76.33	13	1.023	12.712	**<0.01 Significant**
Lumbar spine(9)	66.89	80	13.11	1.814	7.228	**<0.01 Significant**

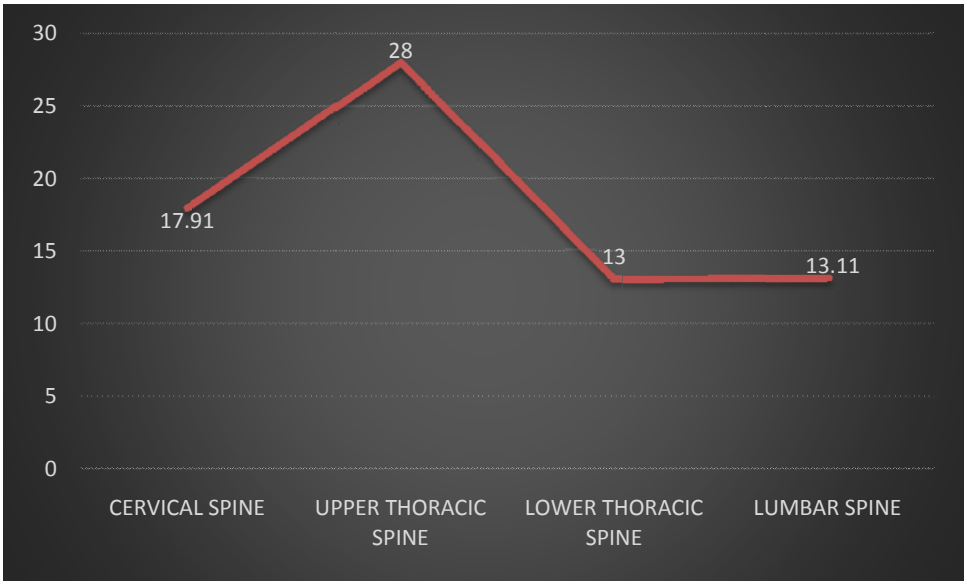


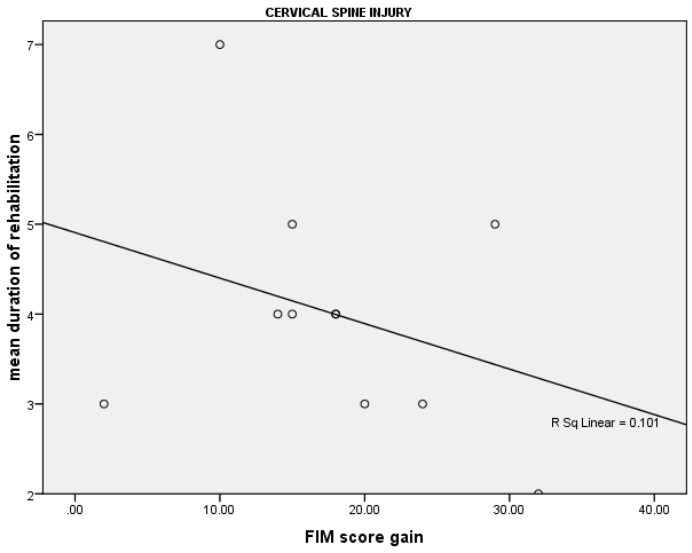
Figure 1. Association between average gain of FIM score and level of lesion

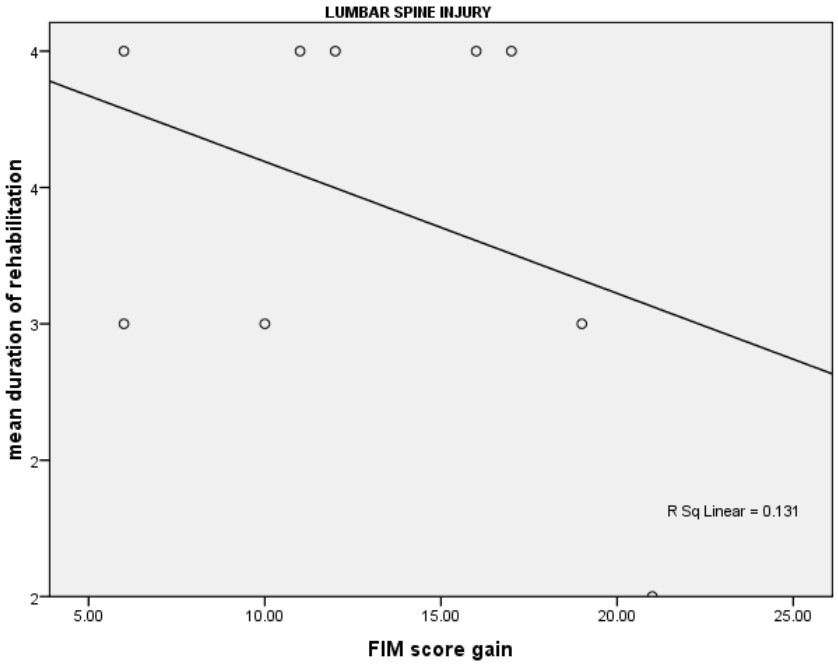
From the above table it is evident that the FIM score during follow up is significantly higher than admission score in cervical, lower thoracic and lumbar spine injury patients. It was statistically significant with p-value of <0.01.

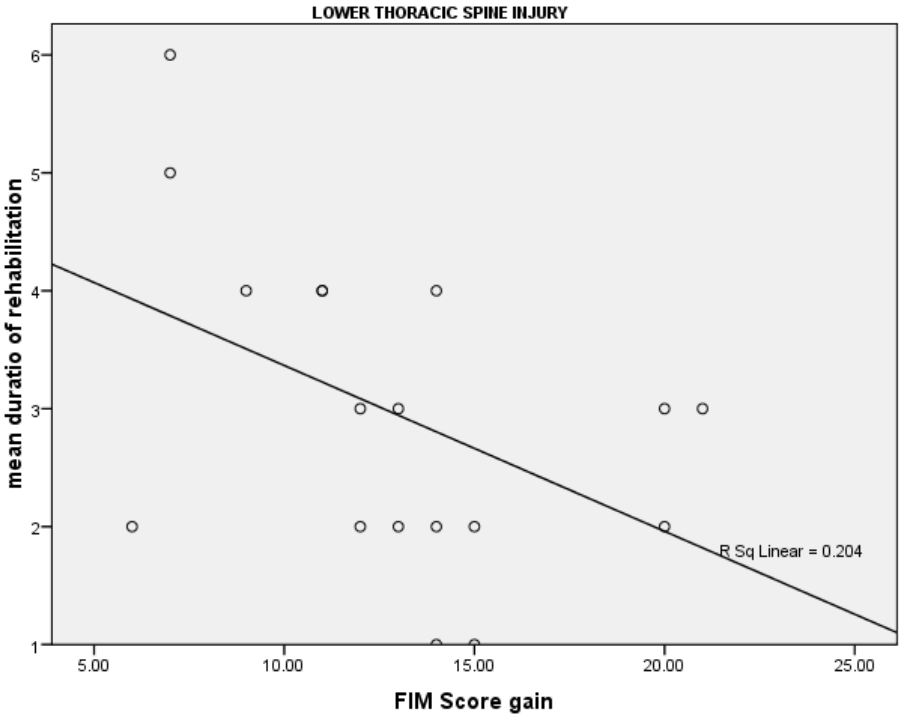
24. Correlation between duration of rehabilitation and FIM score(N=40)

	Cervical spine (11)	Upper thoracic spine (2)	Lower thoracic spine (18)	Lumbar spine (9)
Pearson's R value	-0.318	-1.0	- 0.452	-0.362
Standard error	0.323	0	0.175	0.311
p-value	0.340	-	0.060	0.339

Negative correlation exists between duration of rehabilitation and FIM score at all level of lesion even though it was not statistically significant.




LUMBAR SPINE INJURY
mean duration of rehabilitation
FIM score gain
R Sq Linear = 0.131
4
4
3
2
2
5.00
10.00
15.00
20.00
25.00


LOWER THORACIC SPINE INJURY
mean duratio of rehabilitation
FIM Score gain
R Sq Linear = 0.204
6
5
4
3
2
1
5.00
10.00
15.00
20.00
25.00

25. Association between age group and FIM score gain(N=40)

Level of lesion	Age group in years (No. of subjects)	Average gain in FIM score	Standard Error	F value	P value
Cervical spine	<20 (0)	-	-	0.871	0.375
	20-40(7)	19.71	3.77		
	40-60 (4)	14.75	2.06		
	> 60(0)	-	-		
Lower thoracic spine	<20 (0)			2.296	0.135
	20-40(12)	14.2	1.26		
	40-60 (4)	9.25	1.65		
	> 60(2)	13	1.02		
Lumbar spine	<20 (2)	15.5	5.5	0.163	0.917
	20-40(4)	13.25	2.8		
	40-60 (2)	11.5	5.5		
	> 60(1)	11	-		

From above table patients of young age demonstrated significant functional outcome following rehabilitation when compared to older age group of patients.

26. Association between gender and FIM score gain(N=40)

Level of lesion	Gender (No. of subjects)	Average gain in FIM score	Standard Error	t-value	P value
Cervical spine	Male (10)	18.7	2.67	0.982	0.352
	Female (1)	10	-		
Lower thoracic spine	Male (14)	12.5	1.2	0.910	0.376
	Female (4)	14.75	1.8		
Lumbar spine	Male (6)	11.33	1.92	1.487	0.181
	Female (3)	16.67	3.38		

In upper thoracic spine injury group both the patients are male hence‘t’ test cannot be done. In other groups females showed significant gain in FIM scores compared males but in terms of functional independence males showed better outcomes.

27. Association between mode of injury and FIM score gain(N=40)

Level of lesion	Mode of injury (No. of subjects)	Average gain in FIM score	Standard Error	t-value	P value
Cervical spine	RTA (7)	19.57	3.822	0.853	0.416
	FOH (4)	15	1.91		
Lower thoracic spine	RTA (5)	12.8	1.07	0.118	0.908
	FOH (13)	13.07	1.38		
Lumbar spine	RTA (2)	11.5	5.5	0.451	0.666
	FOH (7)	13.57	2.01		

Comparing mode of injury and outcome in cervical group, victims of road traffic accidents demonstrated better outcome while in other groups, victims of fall from height demonstrated better outcome. In upper thoracic spine injury group, as each group has only one patient, the‘t’ test cannot be done.

28. Association between preoperative neurological lesion and FIM score gain(N=40)

When comparing pre op neurology and FIM score gain, it was found that patients with incomplete lesions exhibited better FIM score gain when compared to complete neurological deficit group.

Preoperative neurological lesion	Number of subjects (N=40)	Average gain in FIM score	Standard error	F value	p-value
Paraplegia	26	13.73	1.36	1.025	0.393
Paraparesis	4	16.25	2.75		
Quadriplegia	1	15	-		
Quadriparesis	9	18.67	3.08		

29. Association between level of lesion and bladder outcome (N=40)

Level of lesion	Recovered	Incontinent	Total
Cervical spine	6 (54.5%)	5 (45.5%)	11 (100%)
Upper thoracic spine	0	2 (100%)	2 (100%)
Lower thoracic spine	3 (16.7%)	15 (83.3%)	18 (100%)
Lumbar spine	2 (22.2%)	7 (77.8%)	9 (100%)

Chi-square value = 5.98 df = 3 p value = 0.113

From the above table it is evident that cervical spine injury patients are having better recovery of bladder function when compared to injuries in other areas. But it was not found to be statistically significant.

30. Association between level of lesion and bladder rehabilitation (N=40)

Methods of evacuation	Cervical	Upper thoracic	Lower thoracic	Lumbar
Reflex voiding	6	0	3	2
Intermittent catheterisation	3	1	10	5
Indwelling catheter	2	1	5	2
Suprapubic catherisation	0	0	0	0

From the table, it is evident that majority of patients has significant improvement in bladder rehabilitation and patients with intact wrist and hand function developed significant functional independence in form of intermittent catheterisation.

31. Percentage of study subjects according to post injury income level (N=40)

Only 31% of patients who were rehabilitated and integrated into society had income and they were able to do house hold and less demanding works. 69% of patients had no income post injury and were supported by their spouse or care givers.

32. Distribution of patients according to household modifications (N=40)

Only five out of 40 patients were able to modify their residence for ease of ambulation and rest of patients were unable to do the modifications. These patients were able to ambulate only with help of their care givers.

DISCUSSION

The mean age of the patient in the study is 35.6 years, comparable to a study from similar developing country like Brazil where it is 34 years with fall injury contributing to major cause of injury. [25]

Irrespective of the age of the patient, all patients have shown significant functional independence when comparing FIM scores of admission, discharge and follow-up in our study.

There is male preponderance in this study with 80 % of the patients are male comparable with the previous studies in developing countries like Brazil, China, Pakistan. [25]

In our study, mode of injuries were road traffic accidents and fall from height, of which fall from height forms the major group constituting 57% of the total study population.

In our study, 13 patients were transported in ideal mode of transportation from site of injury in an ambulance in supine position while rest of 27 were transported with other modes of transportation .This shows the poor awareness of population in carrying out initial acute care in spinal cord injury patients inspite of the fact that 70% of injuries occurred in urban or semi urban places. The lack of awareness in initial care of SCI patients, delay in obtaining expert care in tertiary centre,

inappropriate mode of transportation and severity of injury in initial impact contributes to the complete neurological deficit in majority of patients. In our study, 27 patients presented with complete neurological deficit on presentation which constitutes around 67 % of the study while other 33% presented with incomplete deficit.

The degree of initial impact leading to primary injury plays main role of deciding the degree of neurological injury in our case study and the degree of injury can be reduced to an extent if above factors are considered in management.

T12-L1 junction comprises the majority of site of injury covering more than 50% of the study group and is comparable to study by Bhajracharya et al where they found out T11 –L4 comprises the major site of injury. [38]

Patients with incomplete injuries and minimal vertebral displacement in initial radiographs demonstrated improved outcome ,similar results were given by Bravo et al in 1996 [39]and Pollard et al, 2003[40].

Females had higher rehabilitation FIM score when compared to the males on discharge from rehabilitation centre, however males exhibited more functional independence when compared to females and

this result is comparable to studies by Sipski et al, AMPR, 2004 –study involving 14,433 injuries.[23]

Younger age group of patients demonstrated more functional independence when compared to older individuals and more mobility outcomes and is supported by studies by Cifu et al, APMR, 1999 – study with 375 spine injury cases[19] , Furlan et al 2009[20], Kay et al 2007[21] – Older age has negative influence on outcome.

Recovery in SCI patients depend on initial severity of injury supported by Pollard et al, 2003[40].

Regarding mobility, patients with younger age and incomplete ASIA scale demonstrated improved outcome and similar results were demonstrated by Burns et al ,1997[41].

Main objective of rehabilitation is measured in terms of ambulation of SCI patients .More severe the neurological injury, less is the functional independence in mobility. The degree of neurological impairment and level of lesion determines the ambulatory outcomes of the patient. In our study, as the level of lesion at initial impact is below L1, there is independence in mobility in these patients and these patients were reintegrated into society as community ambulators. While lesions involving thoracic level and complete lesions at presentation

demonstrated less functional independence in ambulation as use of orthosis and splints were required. In cervical level injuries, patient presented with central cord syndrome had better mobility and were reintegrated into society as community ambulators. If wheel chair mobility is considered as functional independence, then majority of patients demonstrated wheel chair mobility after community rehabilitation

Regarding surgical procedure for stabilisation, 19 patients were operated with posterior stabilisation with decompression which corresponds to 75% of study population. Inspite of adequate decompression at time of stabilisation, there was no improvement in neurological outcome if patients presents with complete deficit at initial impact. Patients presented with incomplete deficit benefitted with decompression at time of stabilisation. Study by Miyashita et al, 2012 in 31 patients also concluded that effects of decompression remain unclear. [42]

Complications

Major complications in our study were urinary tract infections and pressure sores were 57% and 37% respectively ,comparable to studies of Haisma et al, J Rehabil Med, 2007 (47% and 36%

respectively) [43]and Chen et al, APMR, 1999[44] also accounted for urinary tract infections and pressure ulceration as major complications.

Risk factors of development of UTI and pressure sores were included ASIA scale A injuries, quadriplegia, older age, violent injury mechanism, cervical level of injuries and concomitant illness and were substantiated by the studies of McKinley et al, APMR, 1999**.** [45]

Increased age was associated with increased incidence of cardio respiratory complications and was associated with reduced incidence of AD, bladder infections and heterotopic ossification. Complete injuries was associated with increased incidences of decubitus ulcers, AD and bladder infection. Cervical spine injuries were associated with increased incidences of AD and were substantiated with studies of Hitzig et al, AJPMR, 2008 [46]

Patients with Frankel A and older ages were more susceptible to develop pressure ulcerations and supported by studies of Vidal et al, 1991[47]**.** AISA A group of patients had a greater risk of respiratory complications, decubitus ulcers and heterotopic ossification in our study as comparable to studies of Aito et al, Spinal Cord, 1991 .[48]

Patients with complete injuries developed more complications and were treated for the same when compared to incomplete injuries and

similar results were given by Dryden et al in2004[49] in a study involving 233 patients.

Regarding bladder and bowel function, patients showed significant functional outcome. Patient with bladder sensation recovery and those able to control urge for micturition for more than 2 hours were managed with intermittent catheterisation either by self or by caregivers. However functional independence attained in hospital setup decreased after discharge into the community.

Community rehabilitation involving reintegrating patients into the community is hindered by architectural barriers inside and around the residence of the patients such as uneven terrains, open defection and steps in home which constituted 60 % of our study. House hold modifications like even terrain , toilet modifications and large doorway and ramps for wheel chair mobility caused additional burden on the patients and 60 % of patients were earning pre injury income of less than 5,000 per month and 69% had no income post injury. Only 5 patients out of 40 patients were able to do household modifications.

In our study, post injuries 69% of patients had no income and were depend on spouse or relatives while rest of patients changed their works and were confined to house hold and less demanding works.

"The objective of the study i.e. Rehabilitation Outcome study reveals inpatient rehabilitation has got significant functional gains in terms of self-care & wheel chair mobility avoiding complications like pressure sores & UTI as evidenced by FIM scores. (FIM Graph) and improved functional dependence. The overall Rehabilitation outcome of SCI patients were affected by multiple factors like family, level of education, occupation, social environment, community support and efficient mobility rehabilitation.

District rehabilitation centres in each district, vocational rehabilitation centres in head quarter, vocational evaluators and social welfare officers of the tertiary care hospitals in association with non – governmental social welfare organisations were involved in the effective rehabilitation of spine injury patients and helping in reintegrating the patients to join the society.

This rehabilitation outcome study is limited by small sample size cross sectional nature, data from a single rehabilitation sitting and there is lack of community based controls.

CONCLUSION

1. The spinal cord injury has a high male dominance with an average age group of 20-40 years.
2. Fall from a height constitute a major cause of spinal cord injury. The lack of awareness of first aid management of the spinal cord injured patient and transportation method has worsened the degree of injury.
3. Early surgical stabilization at tertiary care hospitals is needed to improve the rehabilitation outcome of the SCI patients.
4. Decompression of fractures at time of stabilisation has no effect on postoperative recovery of neurology in patients with complete neurological deficit.
5. Complications in these patients are minimised with effective rehabilitation. Functional improvement is significant in all patient despite majority of patients had complete spinal cord injury at presentation.
6. Younger age patients showed more functional dependence when compared to older age groups and males showed more functional outcome compared to females.

7. Patients with incomplete injuries and more caudal level of injuries showed better ambulation outcome, however majority of patients exhibited more functional independence in ambulation.
8. Prognosis of bladder and bowel outcome in complete spinal cord injury patients are poor but can be functionally modified by comprehensive rehabilitation.
9. Loss of occupation, unable to adapt to newer vocation and subsequent financial loss burdens the SCI patient and vocational evaluation and counselling is important in SCI rehabilitation.
10. Environmental barriers at home and family support play an important role and this needs counselling in aspects of social security and environmental modifications.
11. Comprehensive Rehabilitation centres integrated with community based rehabilitation will further improve the quality of life and will integrate SCI patients as productive members of the society.

CASE ILLUSTRATION - 1

PRE OPERATIVE EVALUATION:

Name: Ms. Venmani

Age/ Sex: 18/F

IP No: 44325

Mode of injury: Fall from height

Time from injury to admission: 8 hours

Associated injuries: -Nil

Diagnosis:L3 Burst Fracture with complete paraplegia

Preop Neurology: complete paraplegia

SURGICAL EVALUATION:

Time delay from injury to surgery : 25 days

Procedure done:Posterior Stabilisation with decompression

POST OPERATIVE EVALUATION :

Follow up period :6 months

Neurology Recovery: recovering

REHABILITATION OUTCOME:

Rehabilitation period: 3 months

FIM score @ Admission:70

Discharge:80

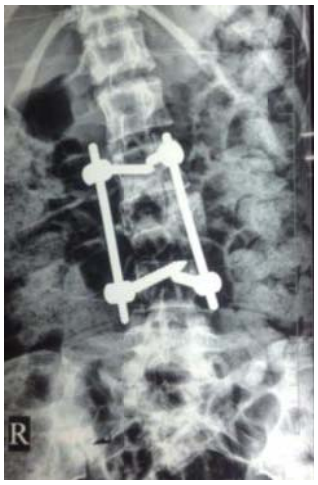
Mobility status: walking with crutches and AFO

Bladder & Bowel outcome: Incontinent

Complication: Pressure ulcer, post op infection

PREOP XRAYS

POST OP XRAYS



CASE ILLUSTRATION - 2

PRE OPERATIVE EVALUATION:

Name: Mr. Anbazhagan

Age/ Sex: 42/M

IP No: 5006

Mode of injury: Road traffic accident

Time from injury to admission: <8 hours

Associated injuries: -Nil

Diagnosis:C5 & C6 fracture with incomplete deficit

Preop Neurology: Quadriparesis

SURGICAL EVALUATION:

Time delay from injury to surgery : 46 days

Procedure done: C4-C7 stabilisation with plate fixation

POST OPERATIVE EVALUATION :

Follow up period :14 months

Neurology Recovery: Recovering

REHABILITATION OUTCOME:

Rehabilitation period:4 months

FIM score @ Admission:47

Discharge:56

Mobility status: Standing with HKAFO with spinal support

Bladder & Bowel outcome: Continent

Complication: Pressure ulcer , Urinary infection

PREOP MRI

CASE ILLUSTRATION 3

PRE OPERATIVE EVALUATION:

Name: Mr.Raja

Age/ Sex: 28/M

IP No: 12186

Mode of injury: Road traffic accident

Time from injury to admission: >8 hours

Associated injuries: -Nil

Diagnosis:D12 compression fracture

Preop Neurology: Complete paraplegia

SURGICAL EVALUATION:

Time delay from injury to surgery : 17 days

Procedure done: Posterior Stabilisation

POST OPERATIVE EVALUATION :

Follow up period :6 months

Neurology Recovery: Yes

REHABILITATION OUTCOME:

Rehabilitation period:4 months

FIM score @ Admission:74

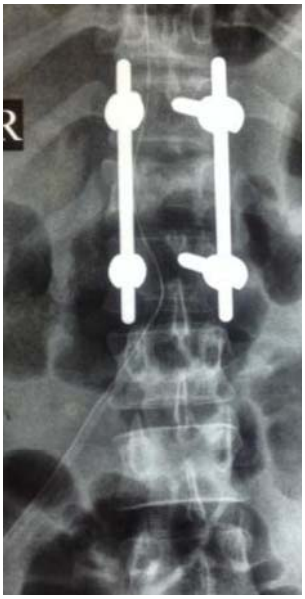
Discharge:83

Mobility status: walking with walker and AFO

Bladder & Bowel outcome: incontinent

Complications: Pressure ulcer

PREOP XRAY:



CASE ILLUSTRATION 4

PRE OPERATIVE EVALUATION:

Name: Mr. Gunaseelan

Age/ Sex: 33/M

IP No: 10824

Mode of injury: Road traffic accident

Time from injury to admission: > 8 hours

Associated injuries: -Nil

Diagnosis:C4 burst fracture

Preop Neurology: Incomplete quadriparesis

SURGICAL EVALUATION:

Time delay from injury to surgery :45 days

Procedure done: C4 corpectomy and fusion

POST OPERATIVE EVALUATION :

Follow up period : 17 months

Neurology Recovery:yes

REHABILITATION OUTCOME:

Rehabilitation period: 3 months

FIM score @ Admission:86

Discharge:110

Mobility status: Community ambulator

Bladder & Bowel outcome: Continent

Complications : Urinary infection

PATIENT INFORMATION SHEET

TITLE OF THE STUDY: **PROSPECTIVE AND RETROSPECTIVE ANALYSIS OF ORTHOPAEDIC & DOMICILIARY REHABILITATION OUTCOME OF SPINE INJURY PATIENTS TREATED WITH CONSERVATIVE AND OPERATIVE METHODS**

We are conducting a study on "Prospective and retrospective analysis of orthopaedic & domiciliary rehabilitation outcome of spine injury patients treated with conservative and operative methods" among patients admitted in the Institute of Orthopaedics & Traumatology & Institute of Rehabilitation Medicine, Rajiv Gandhi Government General Hospital, Chennai.

The purpose of this study is to to analyse the efficacy of the comprehensive rehabilitation on the final outcome of the SCI patient and also to study the role of demography statistics, mode of injury, commonly adopted Acute care management, social and environment barrier in final outcome The privacy of the patients in the research will be maintained throughout the study. In the event of any publication or presentation resulting from the research, no personally identifiable information will be shared.

Taking part in this study is voluntary. You are free to decide whether to participate in this study or to withdraw at any time; your decision will not result in any loss of benefits to which you are otherwise entitled.The results of the special study may be intimated to you at the end of the study period or during the study if anything is found abnormal which may aid in the management or treatment.

Signature of Investigator Signature of Participant

Date :

PATIENT CONSENT FORM

Study Detail : PROSPECTIVE AND RETROSPECTIVE ANALYSIS OF ORTHOPAEDIC & DOMICILIARY REHABILITATION OUTCOME OF SPINE INJURY PATIENTS TREATED WITH CONSERVATIVE AND OPERATIVE METHODS

Study Centre : Rajiv Gandhi Government General Hospital, Chennai.

Patient's Name :

Patient's Age :

Identification Number :

Patient may check (√) these boxes

a) I confirm that I have understood the purpose of procedure for the above study. I have the opportunity to ask question and all my questions and doubts have been answered to my complete satisfaction. ☐

b) I understand that my participation in the study is voluntary and that I am free to withdraw at any time without giving reason, without my legal rights being affected. ☐

c) I understand that sponsor of the clinical study, others working on the sponsor's behalf, the ethical committee and the regulatory authorities will not need my permission to look at my health records, both in respect of current study and any further research that may be conducted in relation to it, even if I withdraw from the study I agree to this access. However, I understand that my identity will not be revealed in any information released to third parties or published, unless as required under the law. I agree not to restrict the use of any data or results that arise from this study. ☐

d) I agree to take part in the above study and to comply with the instructions given during the study and faithfully cooperate with the study team and to immediately inform the study staff if I suffer from any deterioration in my health or well being or any unexpected or unusual symptoms. ☐

e) I hereby consent to participate in this study. ☐

f) I hereby give permission to undergo detailed clinical examination, Radiographs, blood investigations and surgical procedure as required. ☐

Signature/thumb impression

Patient's Name and Address:

Signature of Investigator:

Study Investigator's Name: **Dr. Pramod Kumar Mohan**

INSTITUTIONAL ETHICS COMMITTEE
MADRAS MEDICAL COLLEGE, CHENNAI 600 003

EC Reg.No.ECR/270/Inst./TN/2013
Telephone No.044 25305301
Fax: 011 25363970

CERTIFICATE OF APPROVAL

To
Dr.Pramod Kumar Mohan
Post Graduate in M.S. Orthopaedic Surgery
Madras Medical College & RGGGH
Chennai 600 003

Dear Pramod Kumar Mohan,

The Institutional Ethics Committee has considered your request and approved your study titled **"RETROSPECTIVE & PROSPECTIVE ANALYSIS OF ORTHOPAEDIC AND DOMICILARY REHABILITATION OUTCOME OF SPINE INJURY PATIENTS TREATED WITH CONSERVATIVE AND OPERATIVE METHODS – LONG TERM PROSPECTIVE AND RETROSPECTIVE STUDY "- NO. 11042016.**

The following members of Ethics Committee were present in the meeting hold on **05.04.2016** conducted at Madras Medical College, Chennai 3

1.Dr.C.Rajendran, MD.,	:Chairperson
2.Dr.Isaac Christian Moses,MD.Ph.D.Dean(FAC)MMC,Ch-3	:Deputy Chairperson
3.Prof.Sudha Seshayyan,MD., Vice Principal,MMC,Ch-3	: Member Secretary
4.Prof.B.Vasanthi,MD., Prof.of Pharmacology.,MMC,Ch-3	: Member
5.Prof.P.Raghumani,MS, Prof. of Surgery,RGGGH,Ch-3	: Member
6. Prof.Md.Ali,MD.,DM.,HOD-MGE, MMC,Ch-3	: Member
7.Prof.Baby Vasumathi, Director, Inst. of O&G,Ch-8	: Member
8.Prof.K.Ramadevi,MD, Director,Inst.of Bio-Chem,MMC,Ch-3	: Member
9.Prof.M.Saraswathi,MD.,Director, Inst.of Path,MMC,Ch-3	: Member
10.Prof.Srinivasagalu,Director,Inst.of Int.Med.,MMC,Ch-3	: Member
11.Tmt.J.Rajalakshmi, JAO,MMC, Ch-3	: Lay Person
12.Thiru S.Govindasamy, BA.,BL,High Court,Chennai	: Lawyer
13.Tmt.Arnold Saulina, MA.,MSW.,	:Social Scientist

We approve the proposal to be conducted in its presented form.

The Institutional Ethics Committee expects to be informed about the progress of the study and SAE occurring in the course of the study, any changes in the protocol and patients information/informed consent and asks to be provided a copy of the final report.

20/4/16

Member Secretary, Ethics Committee

MEMBER SECRETARY
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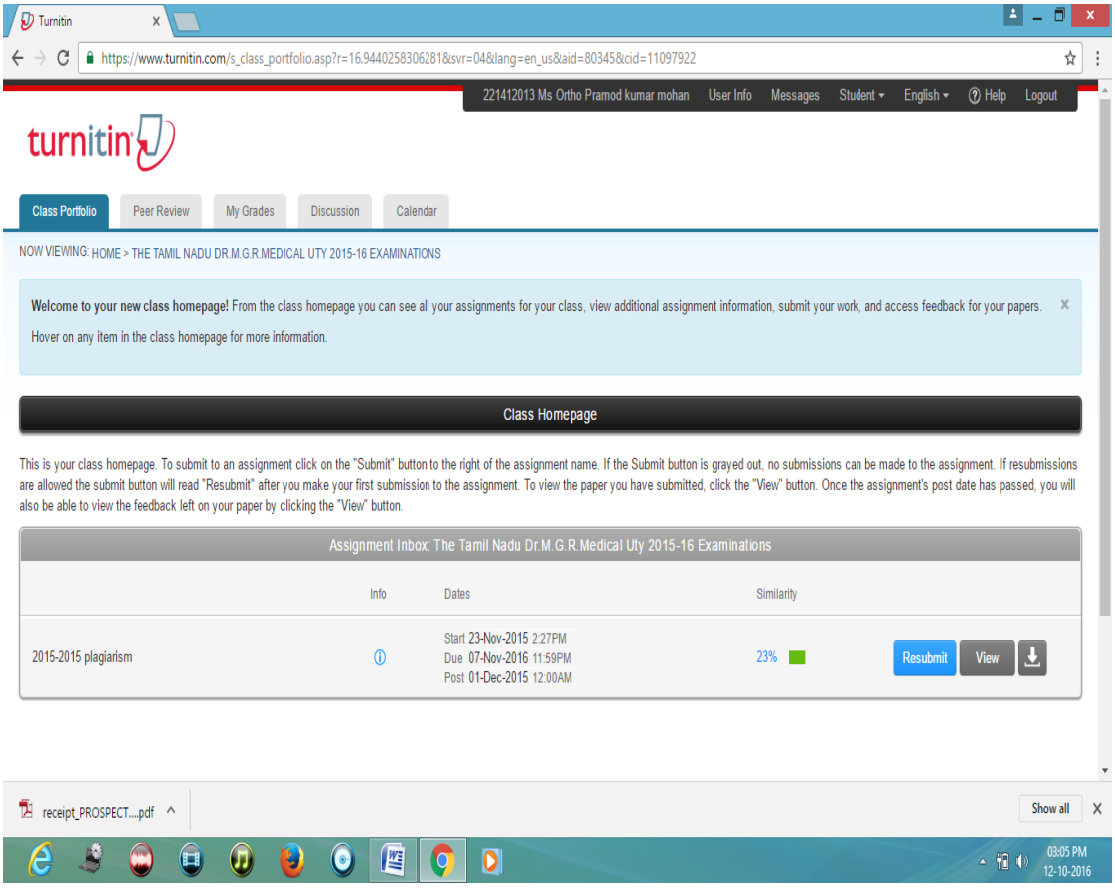
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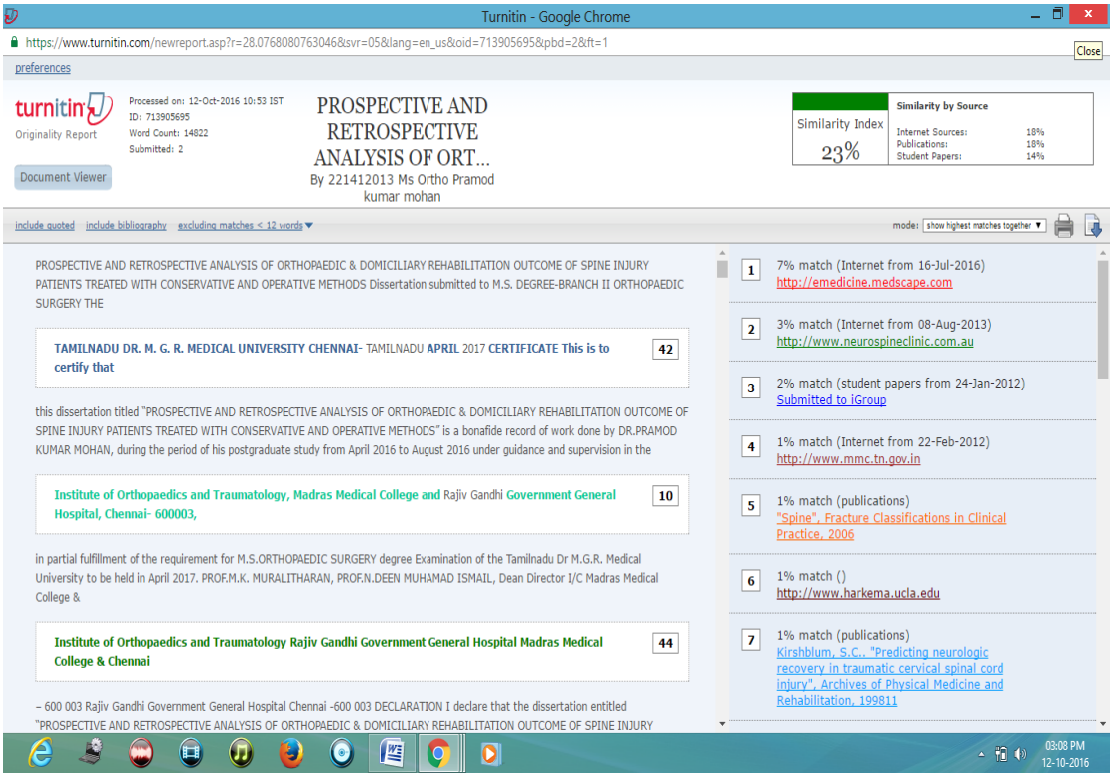
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this dissertation titled "PROSPECTIVE AND RETROSPECTIVE ANALYSIS OF ORTHOPAEDIC & DOMICILIARY REHABILITATION OUTCOME OF SPINE INJURY PATIENTS TREATED WITH CONSERVATIVE AND OPERATIVE METHODS" is a bonafide record of work done by DR.PRAMOD KUMAR MOHAN, during the period of his postgraduate study from April 2016 to August 2016 under guidance and supervision in the
Institute of Orthopaedics and Traumatology, Madras Medical College and Rajiv Gandhi Government General Hospital, Chennai- 600003,
10
in partial fulfillment of the requirement for M.S.ORTHOPAEDIC SURGERY degree Examination of the Tamilnadu Dr M.G.R. Medical University to be held in April 2017. PROF.M.K. MURALITHARAN, PROF.N.DEEN MUHAMAD ISMAIL, Dean Director I/C Madras Medical College &
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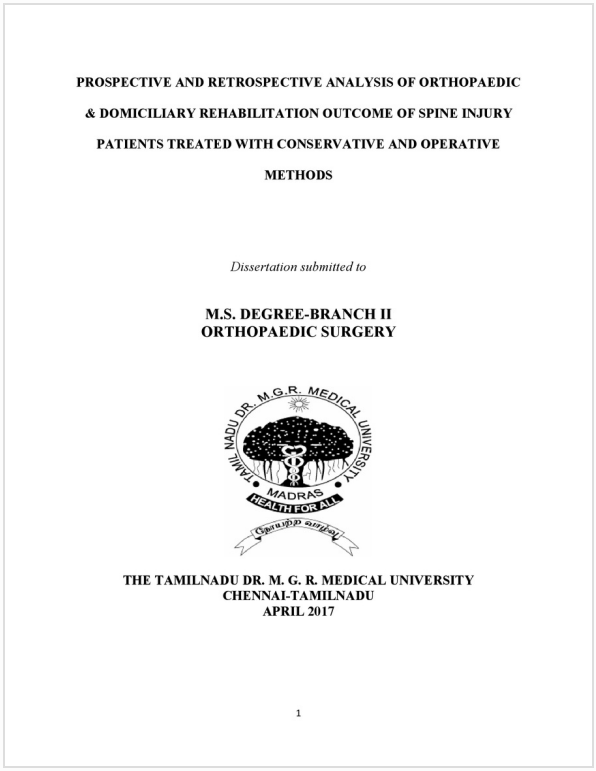

PROSPECTIVE AND RETROSPECTIVE ANALYSIS OF ORTHOPAEDIC & DOMICILIARY REHABILITATION OUTCOME OF SPINE INJURY PATIENTS TREATED WITH CONSERVATIVE AND OPERATIVE METHODS

Dissertation submitted to

M.S. DEGREE-BRANCH II
ORTHOPAEDIC SURGERY

THE TAMILNADU DR. M. G. R. MEDICAL UNIVERSITY
CHENNAI-TAMILNADU
APRIL 2017

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MASTER CHART FOR REHABILITATION OUTCOME IN SPINE INJURY PATIENTS

S.no	Name	Age/ Sex	Ip no	Mode of injury	Preop neurology	Level of lesion	Associated injuries	Duration		Treatment	Post op Neurology Recovering or not	ASIA Scale	Mean duration of rehabilitation (Month)	FIM Score	FIM Score	Complication	Mobility Outcome	Bladder and Bowel outcome
								To Surgery (Days)	Follow Up (Months)					Admission	Follow up			
1	Mr.Elangovan	33/M	25651	FOH	Paraplegia	L1	Nil	8days	26	Stabilisation & decompression	No	Complete A	4	64	80	CKD,Pressure Ulcer,Urinary infections	Walking with B/L hkafo with walkers	Incontinent
2	Mr.Rajendran	43/M	89159	FOH	Paraplegia	D12	Nil	11	11	Stabilisation & decompression	No	Complete A	2	60	73	Pressure Ulcer, Urinary infection	Wheel chair mobility	Incontinent
3	Mr.Poongan	40/M	106464	FOH	Paraplegia	L1	Nil	18	10	Stabilisation & decompression	No	Complete A	4	58	64	Pressure ulcer, urinary infections	B/L HKAFO with crutches	Incontinent
4	Ms.Vijaya	35/F	33358	FOH	Paraplegia	D11	B/L calcaneum fracture	29	26	Stabilisation alone	Yes	Incomplete D	3	60	80	B/L e Ankle equines, pressure Ulcer	Walking with B/L HKAFO and walker	Incontinent
5	Mr.Guna seelan	36/M	10824	RTA	Quadriparesis	C4	Nil	30	17	Corpectomy & Fusion	Yes	Incomplete D	3	86	110	Urinary Infection	Community ambulator	Recovered
6	Mr.Annamalai	23/M	43300	FOH	Paraplegia	L1	SPR,IPR#Rt Iliac wing # rt Sacral ala # rt	30	6	Stabilisation & decompression	No	Complete A	4	62	74	Pressure Ulcer,Ankle Equinus	Wheel chair mobility	Incontinent
7	Mr.Natarajan	40/M	35200	FOH	Paraplegia	D11&D12	L1,L2,L3 Transverse process #	15	7	Stabilisation& decompression	No	Complete A	6	55	62	Nil	B/F HKAFO with walkers	Incontinent
8	Mr.Harikrishnan	28/M	27553	FOH	Paraplegia	D12	Shaft of femur # Rt, Electrical Burns	17	11	Stabilisation & decompression	No	Complete A	5	55	62	Nil	B/F HKAFO with walkers	Incontinent
9	Mr.Anbazhagan	52/M	10561	Fall of object	Paraplegia	D11	D9&D10 Spinous process #	6	7	Stabilisation &decompression	No	Complete A	4	54	65	Urinary infections	Wheel chair mobility	Incontinent
10	Mr.Raja	28/M	12186	RTA	Paraplegia	D12	Nil	17	6	Stabilisation & decompression	Yes	Incomplete C	4	74	83	Pressure ulcer	Walking with AFO And crutches	Recovered
11	Mr.Anbalagan	41/M	5006	RTA	Quadriplegia	C5,C6	Nil	46	14	Stabilisation & decompression	No	Complete A	4	47	62	Pressure Ulcer,Urinary infection	Standing with HKAFO and spinal support	Recovered
12	Mrs.Kasiyammal	68/F	51862	Hit By bull	Paraplegia	D12	Nil	55	4	Stabilisation alone	Yes	Incomplete C	2	60	74	Nil	Wheel chair mobility	Incontinent

13	Mr.Mahendra Kumar	65/M	61462	Fall In bathroom	Paraparesis	L3,L4	Nil	-	6	Conservative	No	Incomplete C	4	8 5	9 6	Nil	Wheel chair mobility	Incontinent
14	Mr.Arunyoliselavan	30/M	12031	RTA	Paraplegia	D12	Nil	11	6	Stabilisation alone	No	Complete A	4	6 8	8 2	Urinary Infection,Pressure Ulcer	B/L HKAFO with walker	Incontinent
15	Mr.Kumaresan	28/M	6624	RTA	Paraplegia	D5,D6	Ribs #,Scapula #	8	4	Stabilisation & decompression	No	Complete A	3	5 5	7 0	Nil	B/L HKAFO with walker	Incontinent
16	Mr.Rajendran	43/m	89159	FOH	Paraplegia	D12	Nil	10	12	Stabilisation & decompression	No	complete A	2	6 7	7 3	Pressure Ulcer	B/L HKAFO with walker	Incontinent
17	Ms.Venmani	18/F	44325	Fall from Height	Paraplegia	L3	Nil	24	4	Stabilisation & decompression	Yes	Incomplete C	3	7 0	8 0	Pressure ulcer, post op infection	B/L AFO and crutches walking	Incontinent
18	Ms.Abirami sundari	23/F	7854	Fall from neight	Paraplegia	D7	D3-D6 spinous #	6	4	Stabilisation & decompression	No	Complete A	3	6 9	8 2	Pressure ulcer	Wheel chair mobility	Incontinent
19	Ms.Ezhilarasi	29/F	68081	Fall from height	Paraplegia	L3	B/L Calcaneal #,Proximal Tibia # Lt	21	3	Stabilisation alone	Yes	Incomplete C	3	6 7	8 6	Nil	Wheel chair mobility	Recovered
20	Mr.Balaji	35/M	18478	RTA	Quadriparesis	C3-C4 traumatic disease with central cord syndrome	Nil	31	21	Anterior cervical disectomy and fusion	Yes	Incomplete D	5	5 8	8 7	Febrile illness, stiffness,urinary infection	Walking with crutches	Recovered
21	Mr.Prabakaran	26/M	1540	RTA	Quadriparesis	C6-C7	#Shaft of humerus Rt	60	15	C7 corpectomy and instrumented fusion	Yes	Incomplete C	5	9 1	1 0 6	Pressure ulcer, Urinary infection	HKAFO orthosis and walker	Recovered
22	Mr.Rajasekhar	25/M	18433	Fall from height	Paraplegia	D12	Nil	7	13	Stabilisation and decompression	No	Complete A	2	5 8	7 8	Nil	HKAFO orthosis and walker	Recovered
23	Mr.Janakiammal	60/F	24109	RTA	Paraparesis	D12	#shaft of fibula Lt	2	27	Stabilisation alone	Yes	Incomplete D	3	6 8	8 0	Equinus deformity	Walking with B/L AFO	Incontinent
24	Mr.Sasikumar	56/M	18491	Fall from height	Paraplegia	C7-T1 Subluxation	Nil	16	12	Anterior cervical disectomy & fusion	Yes	Incomplete C	4	6 0	7 4	Pressure Ulcer,Urinary infection	HKAFO orthosis and walker	Incontinent
25	Mr.Vijay	30/M	60438	RTA	Quadriparesis	C5	Nil	43	26	C5 corpectomy and instrumented fusion	No	Incomplete C	3	6 0	6 2	Pressure Ulcer,Urinary infection	Bed mobility	Recovered
26	Mr.Lenin	38/M	102876	FOH	Paraplegia	D8,D11,D12,L1	Nil	21	36	Stabilisation alone	No	Complete A	4	4 9	6 0	Heterotropic ossification,Presure Ulcer, Jt Stiffness	Bed mobility	Incontinent
27	Mrs.Gowri	47/F	104879	Hit by bull	Quadriparesis	C4-C5	Nil	10	10	Corpectomy & cage fixation	Yes	Incomplete C	7	6 0	7 0	Pressure Sore,DVT	Walking with B/L AFO & walker	Incontinent
28	Mr.Nirmala	19/F	45620	FOH	Paraparesis	L1	Nil	36	14	Stabilisation & decompression	Yes	Incomplete C	2	6 3	8 4	Pressure Sore,jt Stiffness	Walking with AFO & walker	Incontinent
29	Mr.Ramaraj	26/M	15016	RTA	Quadriparesis	C6-C7	Nil	26	5	ACDF&Bone grafting	Yes	Incomplete D	2	4 8	8 0	Urinary infection	Walking with crutches	Incontinent
30	Mr.Suresh	27/M	108626	FOH	Quadriparesis	C5	Nil	10	10	Corpectomy & cage fixation	Yes	Incomplete C	4	4 9	6 7	Pressure Ulcer	Walking with walker ,without orthosis	Incontinent
31	Mr.Vijayakumar	24/M	32689	FOH	Quadriparesis	C5-C6	Radial & Ulnar Styloid #	21	30	Corpectomy & cage fixation	Yes	Incomplete C	4	4 0	5 8	Pressure Ulcer,Urinary Infection	Stands with HKAFO & spinal support	Recovered
32	Mr.Nallathambi	41/M	9247	RTA	Paraplegia	L1	Nil	30	13	Stabilisaton & decompression	Yes	Incomplete C	4	5 9	7 6	Pressure Ulcer, Surgical Site	HKAFO and crutches	Incontinent

																infection	walking	
33	Mr.Nagappan	33/M	11324	RTA	Paraplegia	L1	Nil	25	36	Stabilisation & decompression	Yes	Incomplete C	3	7 4	8 0	Impalnt Failure, Pressure Ulcer	Walking with walker	Recovered
34	Mr.Ganesan	35/M	1605098	RTA	Paraplegia	D8	Nil	10	6	Stabilisation alone	No	Complete A	1	7 2	8 6	Nil	Wheel chair mobility	Incontinent
35	Mr.Kannappan	38/M	18445	FOH	Paraplegia	D12	Rib #	16	10	Stabilisation & decompression	No	Complete A	2	5 8	7 0	Pressure Ulcer	Wheel chair mobility	Incontinent
36	Mr.Jandhar	25/M	2866	FOH	Paraparesis	D12	Distalradius #	23	36	Stabilisation alone	Yes	Incomplete C	3	9 0	1 1 1	Nil	B/L elbow crutches	Recovered
37	Mr.Praveen Kumar	20/M	11194	FOH	Paraplegia	D4,D5	Electric Burns	-	20	Conservative	No	Complete A	2	5 7	9 8	Urinary infection	Wheel chair mobility	Incontinent
38	Mr.Rajasekhar	38/M	65669	RTA	Paraplegia	D9	Nil	60	12	Stabilisaiton &Decompression	No	Complete A	1	5 8	7 3	Nil	Wheel chair mobility	Incontinent
39	Mr.Selvaraj	50/M	72167	RTA	Quadriparesis	C3-C6	Nil	25	12	Laminectomy & decompression	No	Incomplete B	3	6 0	8 0	Urinary infection	B/L posterior tube splint with walker support	Incontinent
40	Mr.Gopal	28/M	27640	FOH	Paraplegia	D12	Nil	17	16	Stabilisation alone	No	Complete A	2	6 5	8 0	Pressure ulcer	B/L KAFO with walker	Incontinent